THE NIAGARA CANTILEVER BRIDGE.

As the American Society of Civil Engineers will, undoubtedly, on the occasion of their coming annual convention, visit this latest and most interesting type of American bridge construction, we reproduce, in this issue, all the descriptive matter accessible. For the very excellent illustrations used, we are indebted to the courtesy of the *Railroad Gazette*.

In ENGINEERING NEWS for 1883-84 will be found, scattered through many papers, about all the descriptive matter that has yet been published concerning the dimensions and erection details of this first true Cantilever bridge built upon American soil. But for the convenience of our readers we reproduce, in a condensed form, the great mass of this data.

The bridge was built by the Niagara Bridge Co., representing chiefly parties interested in the Michigan Central R. R. Co. It is located a very short distance above the famous Roebling railroad suspension bridge, and spans a deep gorge traversed by the rapid current of the Niagara River. The position rendered practically impossible any system of false works, and hence the cantilever type of bridge was peculiarly well adapted to the site.

The Chief Engineer of the Niagara Bridge Co. and the designer of the bridge, was Mr. C. C. Schneider, who had already made the plans for an almost identical structure, then lately built over the Frazer River, in British Columbia.

Upon April 11, 1883, a contract for its construction was signed, with the Central Bridge Company of Buffalo, N. Y., of which company Gen. Geo. S. Field was then President, and Mr. Edmund Hayes, Engineer. On April 15, 1883, excavations for the piers were commenced; on June 26, the first stone was laid in the foundations, which were finished on September 3. The anchorage piers were commenced on August 27, and completed October 1. The steel towers were finished on September 19, 1883, and the erection of the shore-arms of the cantilever commenced September 28. On October 29, work was begun on the river-arms of the cantilever; November 21, the center connection of the lower chord was made; on November 22, the center truss was finished, and on December 20, 1883, the bridge was opened to traffic with due formality.

The following statement of the general dimensions of the Niagara Cantilever Bridge was compiled by us from data furnished by Chief Engineer Schneider, and published in ENGINEERING NEWS of October 6, 1883:

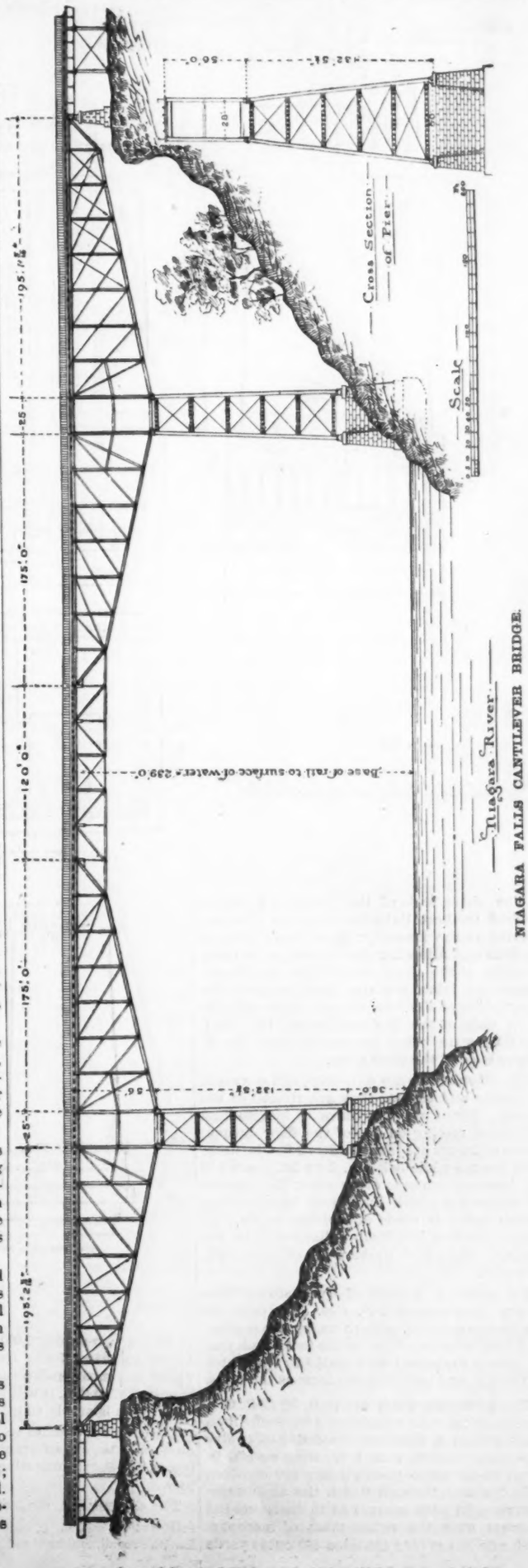
The general dimensions are as follows: Length of bridge proper, from center to center of end pins, 910 ft. 1½ in.; divided into two cantilevers of 395 ft. 2.5 in. each, and one intermediate span of 119 ft. 9 in. The towers are braced wrought-iron structures, 130 ft. 6½ in. high, resting upon masonry piers 39 ft. high; the foundations under the towers are of beton, 8 ft. thick, directly on the rock, forming a uniform, solid and enduring mass.

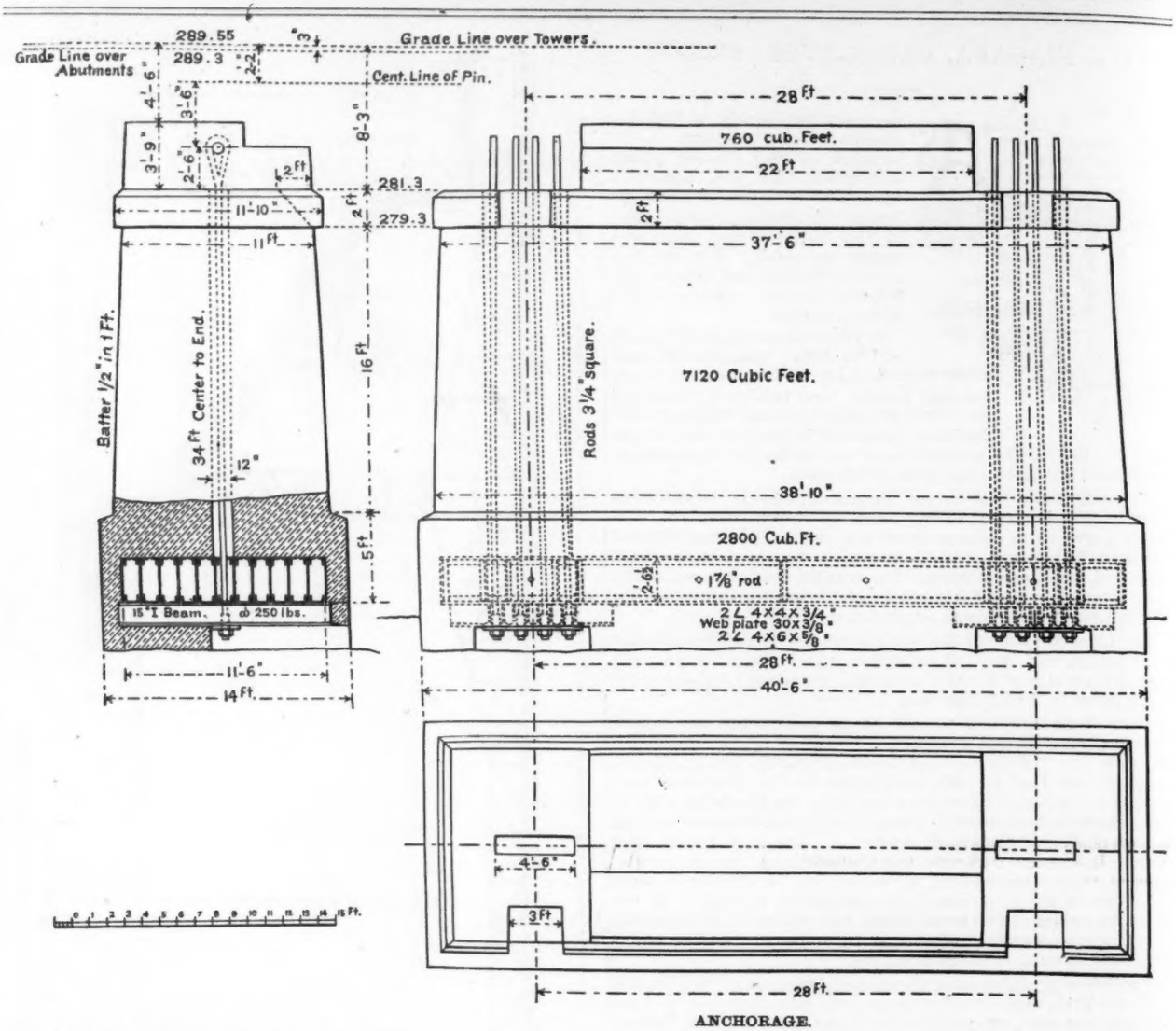
The trusses are two in number, 28 ft. apart between centers; the panels are 25 ft. long, excepting those of the intermediate span, which are 24 ft., and the end panels of the shore-arms of the cantilevers, which are 20 ft. 2.5 in. long. The depth of the cantilever trusses, over the towers, is 56 ft.; and at the ends, 21 ft. for shore ends, and 26 ft. at the river ends.

The structure has been proportioned to carry, in addition to its own weight, a freight train on each track at the same time, weighing one ton per lineal foot, with each train headed by two 76-ton consolidation engines. The factor of safety is 5. Wind bracing has been proportioned for a pressure of 30 lbs. per square foot on a surface twice the area of one face of the truss, plus area of floor system, plus the area of face of train taken at 10 ft. vertical height.

The material used in the superstructure is open-hearth steel and wrought-iron. Towers and heavy compression members, such as lower chords and center posts, are of steel, as are all the pins. All tension members are wrought-iron. The only use made of cast-iron is in the pedestals on the masonry and in filling-rings; the castings at the top of the towers are all steel.

The whole of the superstructure is pin-connected. The towers contain four columns each, and each column is made up of plates and angles in sections of about 25 ft. in length, braced with horizontal struts and with tie-rods. The batter of columns at right angles to the center line of the bridge is 1 in 8. In the cantilever trusses, the lower chords and center posts are made of plates and angles latticed; the intermediate posts are made of 12 in. and 15 in. channels, latticed. The upper chords of the cantilevers are 8 in. eye-bars, the shore-arm having a compression member 18 in. deep, composed of plates and angles packed between the chord-bars.





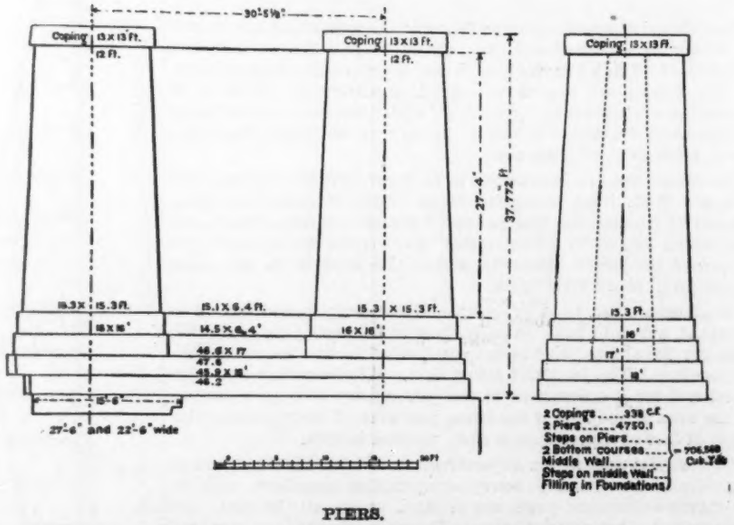
ANCHORAGE.

The shore ends of the cantilevers are attached to short links revolving on pins anchored to the masonry; these links serve as rockers and allow for the expansion and contraction of the shore ends of the cantilevers. Expansion joints are also provided for at the connection of the intermediate span with the river ends of the two cantilevers, the intermediate span being suspended from the extreme ends of the river arms.

The floor beams are 4 ft. deep, and are made of plates and angles; they are riveted to the posts. There are four lines of longitudinal stringers, resting on top of the floor beams; these stringers are plate girders 2 ft. 6 in. deep. The ties are white oak 9 in. by 9 in., spaced 18 in. between centers; every other tie projects to support a plank walk and hand-railing, which latter is made of cast-iron posts 6 ft. apart, and four longitudinal lines of 1½ in. gas piping. The guard timbers are of white oak, 8 by 8 in.

All masonry is built of Queenstown limestone, in courses of 2 ft. rise. The piers for the towers are 12 ft. square under the coping, and have a batter of ½ in. to the foot; each pair of piers is connected by a wall 3 ft. 9 in. thick at the top, and battering the same as the piers.

The anchorage-piers are 11 ft. by 37 ft. 6 in. under coping, with a batter of ½ in. to the foot. They rest on a platform consisting of twelve iron plate girders, 2 ft. 6 in. deep and 36 ft. long; under these plate-girders are eighteen 15-in. I beams, through which the anchorage-bars pass, in such manner as to distribute the pressure over the entire mass of masonry. Each anchorage pier contains 460 cubic yards of masonry, weighing 2,000,000 lbs; as the maximum uplifting force from the cantilevers under the most unfavorable position of load is only 678,000 lbs., it will be seen that this upward force is amply counterbalanced.



PIERS.

The near approaches to the main structure, on both sides, are substantial iron trestle resting on masonry foundations erected upon solid rock.

The dimensions, etc., may be tabulated as follows:

Length over all, centers of end pins	910	ft.	1¾ in.
Length center portion	119	ft.	9 in
Length each cantilever	395	"	2¾ "
Height of wrought-iron towers	130	"	6¾ "
Height of masonry piers	39	"	0 "
Depth of beton foundation	8	"	0 "
Length of panels, cantilevers	25	"	0 "
" " " center girder	24	"	0 "
Trusses apart between centers	28	"	0 "
Depth cantilever trusses, over towers	56	"	0 "
" " " river ends	26	"	0 "
" " " shore ends	21	"	0 "
Depth of floor beams	4	"	0 "
Depth longitudinal stringer	2	"	6 "
Ties, white oak, 18 in. apart	9 in. by 9 in.		
Guard timbers, white oak	8 in. by 8 in.		

The total quantity of material used in the bridge and towers, exclusive of the approaches, is as under:

Steel	1,272,900 lbs.
Wrought-iron	3,093,000 lbs.
Cast-iron	126,000 lbs.
Total	4,491,000 lbs.
Timber in floor	154,000 ft. B. M.
Beton in foundations	31,100 cubic ft.
Masonry in piers	2,800 cubic yds.
Do. anchorage piers	900 cubic yds.

The Niagara River at the crossing point, is about 450 ft. wide, the depth of water is not certainly known, but the current is exceedingly rapid; the distance from the base of rail on the finished bridge, to the surface of water is 239 ft. (See general elevation). The following was the method of erection pursued:

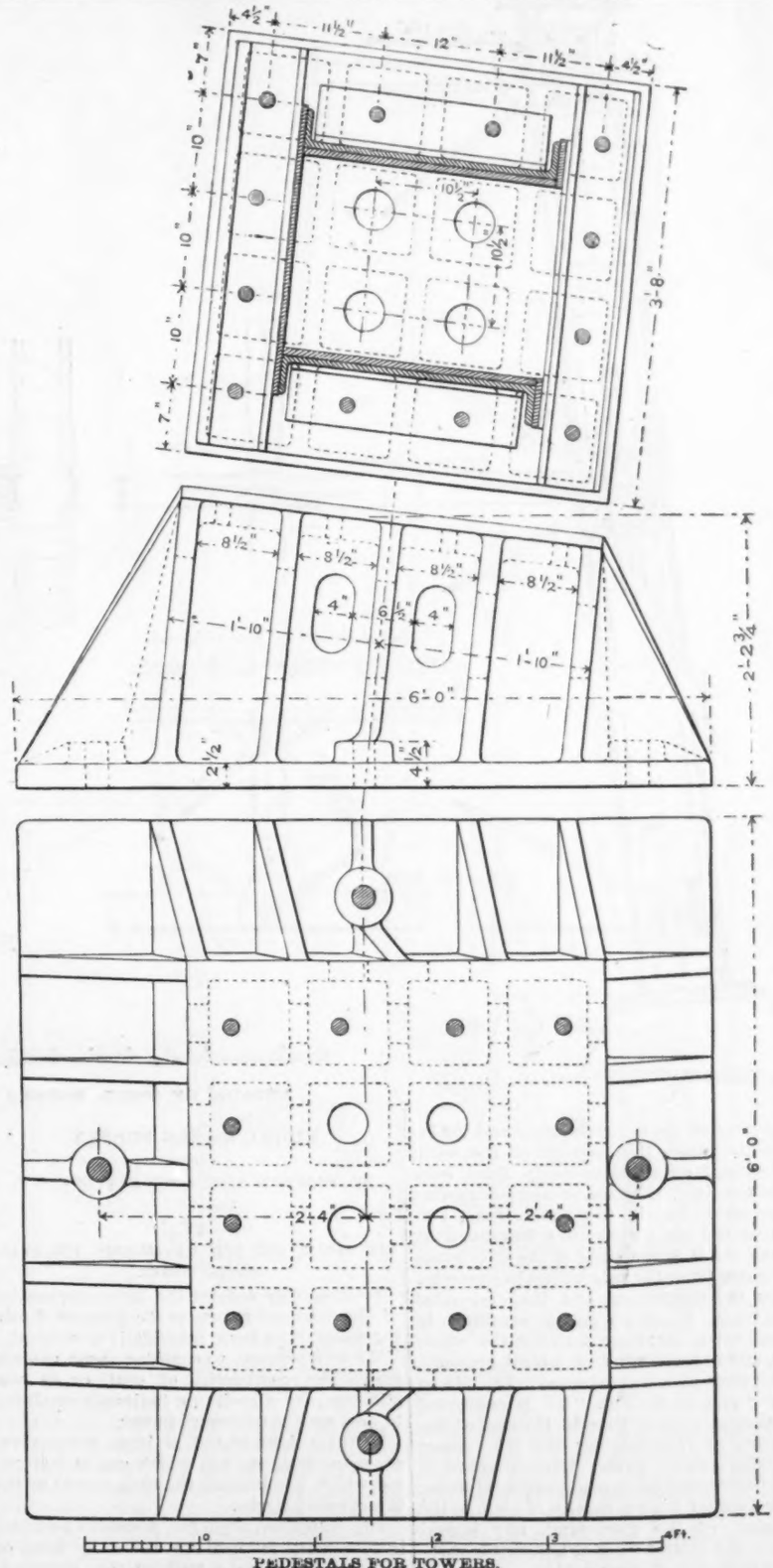
The steel tower having been first erected upon masonry foundations in the solid rock, the shore-arms of the cantilevers were built from wooden false-works, as being the most economical method, and, from the arrangement, perfectly feasible.

The anchorage piers of the shore cantilevers are so fully shown in the illustrations, that little description is needed, beyond what we have already said. The same remark may be made of the details of the towers and their foundations; only explaining that in the "strain-diagram of the towers," the sectional areas of the members are shown in sq. inches, on the right hand side of the diagram, while on the left hand side is given the "strain in pounds produced by the maximum possible loading due to the combined effects of wind pressure and live and dead loads:" "l" denotes strains due live load; "d," strains due dead load; "w," strains from wind pressure; — denotes tension + compression.

The top line of the rectangle drawn above the towers denotes the horizontal center line at which the wind pressure acts on the top chord, which is some little distance above the top chord of the cantilever. The lattice bracing, which enables the cantilever to keep its form against lateral distortion, is not shown in this diagram. The estimated maximum wind pressure on the top and bottom chords respectively, are shown on the diagram in pounds pressure: the figures being written horizontally at the upper and lower right hand corners of the rectangle denoting the cantilever. The maximum wind pressure has been assumed at 30 lbs. per square foot on a surface twice the area of one face of the truss, plus area of floor system, plus the area of face of train taken at 10 ft. vertical height.

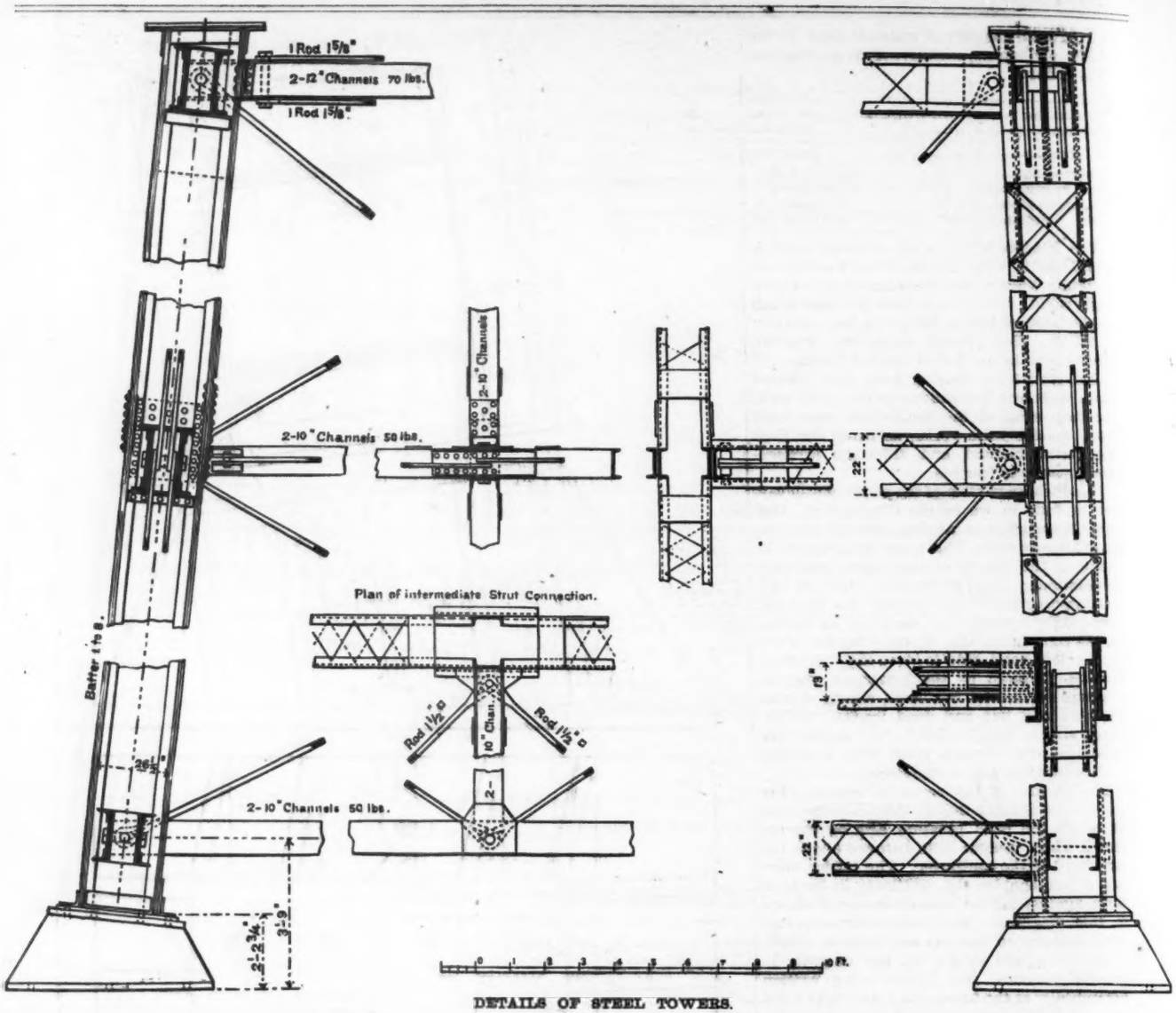
In the erection of the the river-arms of the cantilevers, two travellers were used, which are illustrated and described in ENGINEERING NEWS of March 1, 1884. This portion of the plant was very well designed, and in its use lies the secret of the very rapid connecting together of the different members of the river portion of the bridge. These travellers overhung the finished panels of the structure, 40 ft., and were provided with double derricks and hoisting engines for handling the parts, (the heaviest member weighed 12,000 lbs.) and swinging platforms for the safety and convenience of the workmen. Six cast-iron wheels, each 14 in. in diameter and 8 in. face, ran upon two of the longitudinal stringers of the floorsy tem, and supported the traveller, and permitted its rapid advance, as the bridge was built out panel by panel. The total erection was done under the direct supervision of Mr. S. V. Ryland, who had long previous experience in this delicate branch of the art of bridge construction, with the firm of Kellogg & Maurice, and who is at this date in charge of the erection of the St. John's cantilever bridge, in New Brunswick.

The principles upon which this bridge was designed are too well known to the engineering fraternity to need an extended description here. But at the risk of some repetition we will mention that the Niagara Bridge in question is made up of two towers, founded on the opposite banks of the river, and each supporting, near its center, a girder with a horizontal top and an inclined bottom chord; these two girders do not meet at the middle of the river by about 120 ft., and between and connecting them is a straight suspended truss. In the present case, the shore arms of the main girders were built by means of false works, as soon as the towers were completed; though had it been necessary, the design would have permitted the use of the same method of erection adopted in the building of the river-arms.



PEDESTALS FOR TOWERS.

The shore-arms or cantilevers being first finished, their extreme ends were securely anchored, by the links, pins and bottom platform of built-beams, shown in the anchorage plans, to a mass of masonry, that in its dead weight, far exceeded the lifting tendency of the dead and live loads upon the river cantilevers. With the shore-arms firmly held down, it was possible, by the design of the truss, to build out the river-arms, panel by panel, until the whole space was spanned by



DETAILS OF STEEL TOWERS.

the meeting of the two river-arms and the intermediate truss; this portion of the work being carried on simultaneously from both sides of the river. Expansion and contraction are provided for, in the short links, surmounting the main anchorage links, and by the links "A" at the ends of the river-arms, which latter form the sole vertical connection between the cantilevers and the suspended central truss. To obtain lateral continuity in the three truss members forming the whole bridge, and to resist wind or lateral pressure, the following plan was adopted: The pin on the lower end of the link "A" is connected by horizontal slotted bars to the end of the cantilever, in such manner that the center truss slides between guides firmly attached to the cantilever, and as the connection is further secured by wind braces (shown in plan in the illustration of the river-arm), any lateral motion in the central truss is impossible without first shearing off these guides.

By making use of the stiffened bottom chord of the center truss, this part of the bridge was connected in the same way as were the cantilevers proper.

The natural features of the bridge-site, the rapidity of erection, the comparative economy in cost, and the perfect safety with which the whole work was done, make this structure mark an important epoch in bridge construction in America.

ENGINEERING NEWS: Three months for One Dollar.

RURAL WATER SUPPLY.

BY CHARLES L. HETT, ASSOC. MEM. INST. C. E.

IV.

GAS, STEAM, AND HOT AIR ENGINES FOR SMALL WATER WORKS.*

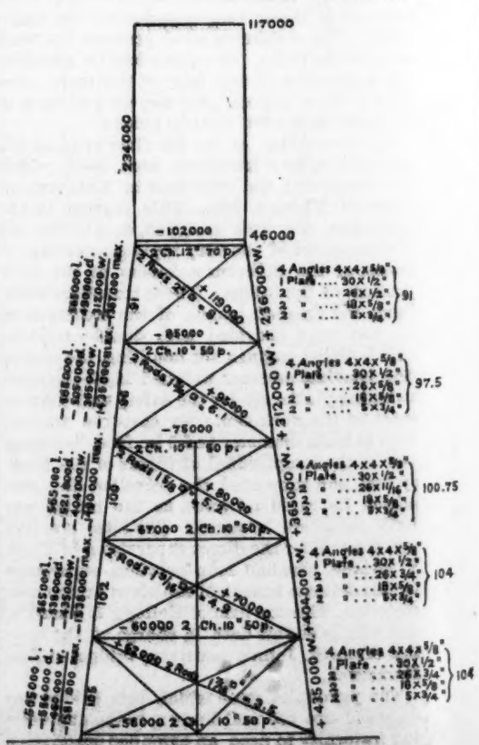
IN foregoing articles the direct application of the forces of nature to the purpose of raising water, have been principally treated of.

We now propose to consider those cases in which the combustion of coal, or its constituents, are directly or indirectly employed to produce the necessary power.

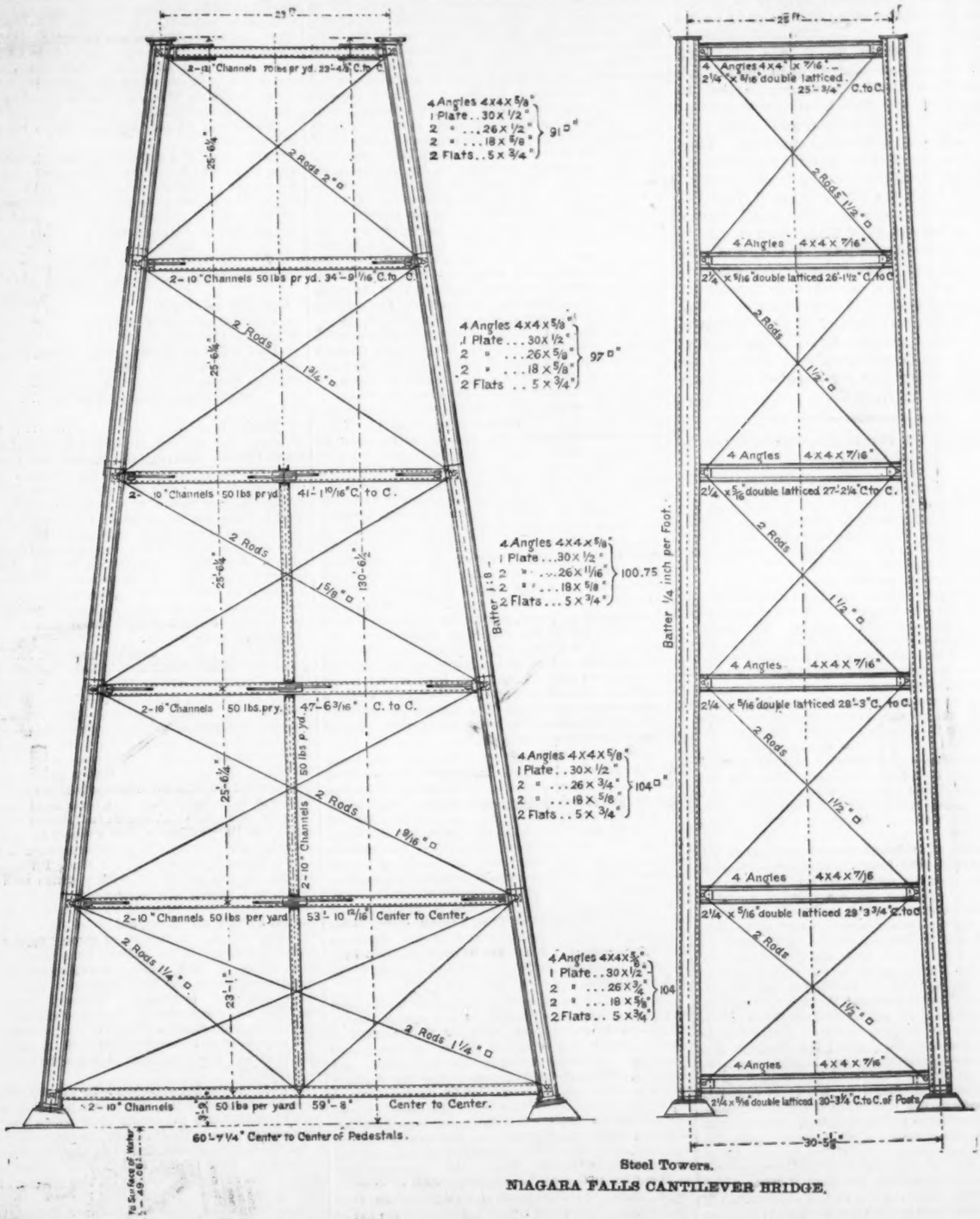
In the neighborhood of large towns there are many residences to which gas is laid on; but which are beyond the area served by the towns water works.

The water required for domestic purposes is commonly pumped up either by hand or horse power from a well on the premises. When an engineer is called in he frequently finds that the existing pumps are sufficient, and a gas-engine arranged so as to drive them, will be all that is required. The gas-engine of the earliest days was the Lenoir; in which a mixture of air and gas was exploded at each end of the cylinder by means of electricity. These alternate explosions

* There is now for sale in the United States a considerable variety of small gas, steam and hot air engines for pumping purposes. In New York City, where the Croton water does not rise to even the second floor of the houses, these engines are universally used for filling reservoirs on the roof or upper story of the buildings.—*(Ed. Eng. News.)*



Strain Diagram of Tower.


25 ft.
2-15" Channels 70 lbs pr yd. 29'-4 5/8" C. to C.
4 Angles 4x4x5/8"
1 Plate .. 30 x 1/2"
2 " ... 26 x 1/2"
2 " ... 18 x 5/8"
2 Flats .. 5 x 3/4"
91 □"
25'-6 3/4"
2 Rods 2" □
2-10" Channels 50 lbs pr yd. 34'-9 1/16" C. to C.
4 Angles 4x4x5/8"
1 Plate ... 30 x 1/2"
2 " ... 26 x 5/8"
2 " ... 18 x 5/8"
2 Flats .. 5 x 3/4"
97 □"
2 Rods
1 3/4" □
2-10" Channels 50 lbs pr yd. 41'-1 10/16" C. to C.
4 Angles 4x4x5/8"
1 Plate ... 30 x 1/2"
2 " ... 26 x 11/16"
2 " ... 18 x 5/8"
2 Flats ... 5 x 3/4"
100.75
Batter 1:8
2 Rods
1 5/8" □
130'-6 1/2"
2-16" Channels 50 lbs. pr yd. 47'-6 3/16" C. to C.
4 Angles 4x4x5/8"
1 Plate .. 30 x 1/2"
2 " ... 26 x 3/4"
2 " ... 18 x 5/8"
2 Flats .. 5 x 3/4"
104 □"
2 Rods
1 9/16" □
2-10" Channels 50 lbs p. yd.
2-10" Channels 50 lbs per yard 53'-10 12/16" Center to Center.
4 Angles 4x4x5/8"
1 Plate .. 30 x 1/2"
2 " ... 26 x 3/4"
2 " ... 18 x 5/8"
2 Flats .. 5 x 3/4"
104
2 Rods 1 1/4" □
23'-1"
2 Rods 1 1/4" □
2-10" Channels 50 lbs per yard 59'-8" Center to Center.
60'-7 1/4" Center to Center of Pedestals.
To Surface of Water 49.00
Batter 1/4 inch per Foot.
4 Angles 4x4" x 7/16"
2 1/4" x 5/16" double latticed 25'-3/4" C. to C.
2 Rods 1 1/2" □
4 Angles 4x4x7/16"
2 1/4" x 5/16" double latticed 26'-1 1/2" C. to C.
2 Rods
1 1/2" □
4 Angles 4x4x7/16"
2 1/4" x 5/16" double latticed 27'-2 1/4" C. to C.
2 Rods
1 1/2" □
4 Angles 4x4x7/16"
2 1/4" x 5/16" double latticed 28'-3" C. to C.
2 Rods
1 1/2" □
4 Angles 4x4x7/16
2 1/4" x 5/16" double latticed 29'-3 3/4" C. to C.
2 Rods
1 1/2" □
4 Angles 4x4x7/16"
2 1/4" x 5/16" double latticed 30'-3 3/4" C. to C. of Posts
30'-5 5/8"

Steel Towers.

NIAGARA FALLS CANTILEVER BRIDGE.

forced the piston backwards and forwards in the same manner in which the steam acts in a steam engine. Many improvements have been introduced during the last twenty years, and now there are several makers who offer efficient gas-engines to the purchasing public, and who are willing to guarantee them for six months. The first really commercially successful gas-engine was the Otto, of which numbers are in use. The connections of the engine and pump is too simple a matter to require anything but a passing notice. One important point is to arrange the gear, so that the original mode of working can be temporarily reverted to in case of an accident to the gas-engine or mains.

There are other country houses, situated at a distance from any water power, which are not supplied with gas, and are so sheltered by trees that the power of the wind cannot be utilized. Under these circumstances the choice is, leaving animal power out of the question, limited to steam and hot-air engines. Each has advantages peculiar to itself; the former is to be preferred when it can be placed in the charge of an experienced driver, but where such aid is not at hand, the latter would have the preference owing to the impossibility of an explosion.

FILTRATION.*

This subject may be divided into two sections, viz.:—The filtration of water in bulk before it enters the service reservoir, and the purification of the water after its delivery on the premises of the consumer, or in other words, that which is done by the water companies and their customers respectively.

For large works sand filtration still takes the leading place, although other mediums have been tried. Magnetic carbide was used in several instances, but now nothing is heard of it. The Antwerp Water Company are now trying spongy iron on a large scale, and so far their experiment is very satisfactory.

Household filters are most commonly furnished with animal carbon, which answers admirably when new. Recent evidence given before a Royal Commission shows that neglected animal charcoal forms a nursery for minute organisms, whose presence in potable water is most objectionable. In London and other large towns cistern and other filters, whose purifying medium is animal charcoal, obtained from and kept in proper order by the maker's employes, leave little to be desired. For country use I should not think it suitable, and should prefer a filter in which no organic substance is used. It would do no harm if neglected, even if it did no good. The two filters of this class with which we are acquainted, are the spongy iron and the magnetic

* There are numerous examples of Filtration of water in large and small quantity in this country, and new and improved methods are being studied continually. The business now is principally in the possession of two companies, The Farquhar Filter Co., New York City, and the Newark Filtering Co., of Newark, N. J.—(*Ed. Eng. News.*)

carbide. Both these filters have to a certain extent the fault of causing the water to be flat and insipid.

Experiments which have been tried with compressed carbon blocks, such as Adkin's and the Silicate Carbon Company, appear to show that they are free from the objections which apply to loose charcoal, while they answer well as a filtering medium. They should, however, be kept scrupulously clean by brushing and scraping the surface occasionally, and occasionally run dry so that it may become thoroughly ærated. The small blocks possess the advantage of being easily and effectually purified by boiling. It is a great mistake to suppose that water, when filtered, must be pure. As a general rule it may be accepted that filtered, if unwholesome, is less likely to be detected than if it were obtained from any other source. It is, therefore, important to make an occasional test of the water drawn from any filter which has been in use for any length of time.

Combined Sewers versus the Waring System. —A Rejoinder.*

The reply of Mr. Chanute (see ENGINEERING NEWS for May 3rd and 10th, 1884) to my criticism of his lecture on he "Sewerage of Kansas City," presents several points which call, perhaps, for a few further words from me in order that the facts and my own position in regard to them may not be misunderstood.

First of all I would remark that the differences between us grow very largely out of the different stress which in our plans we lay upon the needs of the future as compared with those of the present. Mr. Chanute is much more concerned about the needs and the payments of to-day than about those which will come hereafter. "After us the deluge," would seem to be his motto. In making plans, however, it seems to me, and I think to engineers and prudent men generally, that the future should have greater weight than the present, and particularly in planning works of sewerage. For, if properly built, sewers are the most permanent of all public works. The city of Rome is drained to-day, in part, by sewers built 2,500 years ago. Then, too, mistakes in works of this kind are extremely difficult to rectify. To replace a badly built or insufficient sewer is a work of much greater difficulty than if the first had never been built.

If Kansas City were destined to remain just as it is to-day, I should very freely admit that a complete system of storm-water sewers, though desirable, was not necessary, and that its construction would be unwise. I should further admit that for a considerable part of the city the proper course would be to build sewers for house drainage only, though I should not exclude from them all rain water, and should not build them under the Waring patents. For still other large parts of the city to which no water-pipe has been extended, I should not recommend the present construction of any sewers at all, but should say that a system of earth closets was cheapest and best. But nothing is more certain than that the city will not remain as it is to-day. It is growing faster, perhaps, than any city in the West, and gives certain promise of becoming the most important commercial center in the whole Missouri Valley. Already it has long lines of business houses that would do credit to our oldest cities, and its streets are thronged with a traffic which only the most substantial block pavements will endure. So that, whilst Mr. Chanute can, as he gives us to understand, bear now with great equanimity the rush of storm-water past his property (which, by the way, is unoccupied except by a ruined house and some stables) to cut out deep gulches in the property of his "brick making neighbors," it is not safe to assume that his neighbors, or his own successors, will long be thus patient. On the contrary, we may with confidence assume that in the future, and probably in the very near future, the storm-water will become there the same nuisance that it is in other large cities, and the same means be demanded for its removal.

Of this future demand for storm-water sewers, Mr. Chanute thinks but lightly, and claims that I have greatly exaggerated its importance, and this, notwithstanding the fact that its reality and urgency are confirmed by the experience of the vast majority of large cities, both in this country and in Europe, as well as by a multitude of facts which occur daily under our eyes. In support of his view of the matter he refers to the city of Baltimore, with a population of 322,000 and only eleven miles of storm-sewers, but where, he says, the citizens prefer to have the streets swept by the storm-water, and where in consequence they are "notoriously clean."

Now, even granting that these statements could be taken without any abatement, they could not outweigh the great mass of testimony on the other side. But an examination of the reports of the city officers of Baltimore fails to confirm Mr. Chanute's view of the facts. Judging from this evidence, Baltimore is so far from being a model for other cities in this, or any other sanitary aspect, as to be rather a most excellent example of things to be avoided. In few cities have obsolete methods a stronger foothold. Thus the Mayor [Report for 1880] when speaking of the cobble stone pavements with which their streets are mainly covered, and which he denounces as the poorest of their kind, says they are "a characteristic evidence of our reverence for relics of the past." The soil of the city is honeycombed by 80,000 cess-pools, whose evils are intensified by an abundant water supply, and of the few sewers which they have, a considerable part hardly deserve the name. For they are simply old streams arched over by the owners of the land through which they ran, according to their own judgment and convenience, without any regard to alignment or grade, or the needs of other parts of the city. They are, in fact, private property and not controlled by the city either for cleaning or repairs. As for the streets, the storm-water fills them in many places from curb to curb, cleaning them it may be, but rendering them for the time impassable and causing serious damage, of which instances could be cited from every year's reports.

In 1879, for example, the City Commissioner urges the building of a sewer in North Avenue "to carry off the surplus water which has been so destructive along its bed during heavy rains." The next year's report speaks of the accumulation of storm-water at another point as "one of the greatest nuisances in the city," and the Mayor recommends an expenditure of $300,000 for its abatement. And in 1881 the Health Commissioner sums up the facts in regard to the condition of the streets in these words. "A great defect in our streets is the surface drainage. House sweepings, kitchen refuse, slops, etc., find their way into open gutters, pools of water collect at depressed points, giving rise to miasms and odors, that are anything but conducive to health during hot weather, and in winter time invade the adjoining pavements by extension of layers forming broad sheets of ice dangerous to life and limb. All of this nuisance can be obviated and the streets kept dry, and free from offensive and pestilential odors, and sidewalks free from ice by a proper system of sewerage." A picture in which we cannot discern either the "notoriously clean" streets or the contentment of the citizens.

Another point much insisted upon by Mr. Chanute in his reply is, that what I say in regard to the cost of sewerage is unsupported by estimates and figures, and he then gives a number of figures which show, wnat I had no thought of denying, that the Waring system by itself will cost less than the combined system. The only statement in regard to cost made in my paper, was to the effect that the combined system plus the house drainage system, would cost more than the combined system alone—a statement which, I submit, does not need to be supported by anything, and which my critic himself will not, I think, deny. What he does claim is not a contradiction of this statement but a modification of it, viz: that by methods of economy which he indicates, the full cost of a double system need not be incurred.

The first of these economies is, that he would place the storm sewers much nearer to the surface than is practicable where they are used for the drainage of houses. But in regard to this, the fact is, that in very many cases, perhaps the majority, the grades and depths of sewers are determined, not by the requirements of the house drainage, but by the necessity of draining some low point at the upper end. In the deepest sewers this is always the governing consideration. But even where the depth is not fixed in this way the amount that can be saved by putting sewers nearer the surface is not very great. Part of the excavation may be saved, but the cost of masonry, removal of surplus earth, inlets, superintendence and engineering will be unchanged. To test the matter I have, with the aid of Mr. William Wise, assistant sewer commissioner, whose knowledge of everything pertaining to the cost of sewers is unsurpassed, computed for two typical cases in St. Louis, and at actual contract prices, the amount that would be saved by carrying the excavation to a depth of six feet instead of twelve, and find it to be one-twelfth of the whole cost, and this without taking into account the cost of engineering and superintendence. As on many sewers, for the reason already given, no reduction at all can be made, the amount that could be saved in this manner on the whole system of storm sewers will not exceed five per cent. Taking Mr. Chanute's figures for the cost of combined sewers in Kansas City, viz.: $20,727 per mile (although one-third of the whole mileage was built in 1883 at a cost of only $18,273 per mile, or nearly $2,500 less than his figures) this saving would amount to $1,036 and would bring the cost of stone sewers such as he proposes down to about $19,700 per mile. This added to the cost of sewers for house drainage as per his estimate, $10,000 per mile, would give a total of $29,700 per mile as against $20,727 actually spent.

And this brings us to the chief economy which he proposes, which is that a large part of the storm sewers shall be omitted altogether. On this point, however, it should be borne in mind that the part of the system that will be retained will, with rare exceptions, be the lower end, where the volume of water and the consequent nuisance are greatest, and where also the cost of the sewers is a maximum; whilst the part omitted will be the upper end where the difference in the cost of the two classes of sewers becomes rapidly less and less until at the summit it is finally nothing.[1] So that by this method we can only save where the saving is of least value.

For the sake of a more exact comparison of the two plans let us take Mr. Chanute's figures of cost with the deductions therefrom already given, and let us further assume that to complete either system will require 100 miles of sewers. Our data will then be as follows:

Average Cost of Waring Sewers	$10,000 per mile
" " " Combined "	20,727 " "
" " " Shallow Storm Sewers	19,700 " "
Cost of Shallow Storm Sewers at Summit	10,000 " "
" " " " " Lower End	29,400 " "

From this we obtain:

1. Cost of Combined System:

100 miles at $20,727 per mile	$2,072,700

2. Cost of a Double System, with Waring System complete and Storm System half complete:

100 miles Waring Sewers at 10,000 per mile	$1,000,000
50 " Shallow Storm Sewers at $24,550	1,227,500
Total	$2,227,500

or about 15¼ per cent. more than the cost of the combined system. Carrying the figures still further we shall find that a complete Waring system and forty-two and one-half miles of shallow storm sewers will cost the same as a complete system of combined sewers[2] That is to say, for the sameexpenditure we should in the one case have a single system of sewers and complete removal of both house drainage and storm water, and in the other a complicated double system and nearly 60 per cent. of the storm water still unprovided for except by open gutters. Unless, therefore there be some marked sanitary advantage in the double system there can be no question as to which plan is the better investment of the money.

Coming then to the sanitary question, Mr. Chanute makes the remark that I seem to have "quietly ignored all that has been said on the subject by sanitarians both in this country and in Europe," and this notwithstanding my general statement that the combined system is indorsed as promoting the public health by the ablest and most experienced sanitarians and engineers in the world, and a detailed statement of the testimony of the Chief Medical Officer of English Local Government Board to the effect that the air from small sewers is more dangerous than from large ones, Mr. Chanute then quotes at length, as if from a most conclusive sanitary authority, from a report on methods of sewerage made to the New York State Board of Health by Mr. James T. Gardner of the State Topographical Survey. In this report the author states with many italics, as if he were announcing some great discovery, that the evil effects of sewer air are due not to sewer gas, for no such gas exists, but to bacteria; that "ideal hot beds" for the production of these "fatal organic germs" are found in the walls of large sewers, the air from which is "still deadly, notwithstanding every engineering device has been exhausted to keep them clean and well ventilated." Without further ado, therefore, he pronounces the combined system of sewerage to be, from a sanitary point of view, a failure, and then goes on at much length to set forth the surpassing merits of the "American plan" designed by Col. George E. Waring Jr.

Now before allowing ourselves to be greatly disturbed by these rather startling statements, it will be well to look somewhat into the proofs upon which they rest, Mr. Gardiner not having taken the trouble to give them to us. Doing this, we find, first of all, that the researches of Pasteur, Koch, Cohn, and Tyndall, to whom the greater part of what is known on this subject is due, have shown beyond a doubt that bacteria, the "fatal organic germs" of which Mr. Gardner speaks, are of many species, differing widely in their characteristics and conditions of growth, and that the vast majority of them, moreover, are entirely harmless to animal life. The bacteria which produce ordinary fermentations and putrefaction may be breathed or even introduced into the blood, with entire impurity.[3] The presence of other species in the digestive tract is normal, and perhaps even necessary to its proper functions.[4] Disease producing bacteria are the exception, not the rule, and that these kinds are specially produced on the walls of large sewers is absolutely without proof. The "hot beds," of which Mr. Gardner speaks, are indeed well characterized as "ideal."

---

* Read before the Engineers' Club of St. Louis, May 7th, 1884, by ROBT. MOORE, MEM. OF THE CLUB, M. AM. SOC. C. E.

[1] Thus the sewer whose average cost we have found to be $19,700 per mile, will at the summit cost at the rate of $10,000, and at the lower end at the rate of $29,400 per mile. The average cost of the lower half will be $24,550 and of the upper half $14,850.

[2] The exact figures are as follows:

100 Miles Waring Sewers, @ $10,000	$1,000,000
42½ " Storm-sewers, @ 25,277.50	1,074,294
Total	$2,074,294

[3] See Gradle on Bacteria, p. 79.

[4] See Gradle on Bacteria, p. 76.

Some extended and careful observations on this subject by M. Miguel, recently published, * show that while the air of an ordinary Paris bed room, regarded as clean enough, contained a mean of 5,260 organic germs per cubic metre, the air of the sewers contained only from 800 to 900 or about one sixth of the former number. These experiments are related with the further remark that in the sewers the germs were the bacteria proper, but that when inoculated in animals they were without effect—though according to Mr. Gardner the effect should have been "deadly." To the same purport are the well established facts that the health of sewer cleaners, a great part of whose lives is spent in the air of large sewers, is as good as that of other laborers; that the construction of such sewers in cities has always been followed by a marked decrease in the death rate, and that the best sanitary record is found in towns sewered on the combined system. On this latter point the testimony of Dr. Buchanan, given in my former paper, who cites no less than six towns sewered on the separate system is very conclusive.

To Dr. Buchanan's testimony, however, Mr. Chanute objects that the experience of Croyden, and the other towns mentioned, is not in point as against the Waring system, for the reason that in none of these was any use made of the automatic flush tanks which characterize that system, although it was shown that the sewers were flushed by other means. In other words, the superiority claimed does not belong to the separate system generally, but only to that particular form of it which has been patented by Col. Waring. With the field of discussion limited in this way, the only experience available to test the Waring system is that of Memphis, this being the only town sewered on this plan of which we have the sanitary record. But here, as I have before shown, the death rate since the construction of the Waring sewers is 36 per 1,000 as compared with 34 in the preceding five years in Memphis, after excluding deaths from yellow fever, and 21 in the last four years in St. Louis.

To these figures my opponent objects, first, that the deaths from yellow fever in Memphis, prior to 1880, should not have been omitted, and that the exemption from the fever since then should be credited to the new sewers. In reply to which I ask, to what, then, shall we credit the like exemption in New Orleans and Grenada and Shreveport and Mobile, in none of which is there the Waring or any other system of sewers, and all of which have had epidemics of yellow fever? As I remarked in my first paper, the yellow fever has not only not visited Memphis since 1880, but it has not visited any other place within 300 miles of Memphis, and surely it is not claimed that the Waring sewers have protected this whole region. In all these cases, the fever has been kept out by quarantine, and I excluded it from the Memphis death rate for the same reason that I excluded cholera from the death rate in St. Louis prior to the construction of sewers there, viz.: that in each case the epidemic was due to causes with which the presence or absence of sewers had nothing whatever to do.

Mr. Chanute further objects that the death rate in Memphis since the sewers were built is less than I have stated it, and that my figures of population do not agree with those used by the President of the Memphis Board of Health, Dr. G. B. Thornton. Dr. Thornton, however, makes no higher claim for his figures than that they are estimates based upon the city directory, and does not profess to be satisfied with them himself.* How utterly delusive such estimates are, none know better than the people of St. Louis, whose health officers, in 1877, upon the same kind of evidence, claimed a population of 500,000, and a death rate of 10.88 per 1000, although the utmost diligence of the census officers, three years later, could find only 350,520. The real number in 1877 could not have exceeded 312,000, or only 62½ per cent. of the number claimed. A smaller correction than this applied to Dr. Thornton's figures will bring them down to those used by me, which are based upon the United States census of 1880, with an assumed rate of increase for subsequent years of four per cent. per annum.

That this rate is not an absurd one, as Mr. Chanute appears to think, is shown by the fact that the average annual rate of increase, since 1870, of all cities in the United States, which in 1880 had a population of 50,000 or over, was only 3⅞ per cent., the rate for southern cities being considerably less. In Baltimore, for example, it was 2⅛, in Washington 3⅛, in Richmond 2⅛, in Louisville 2⅛, and in New Orleans least of all, being but 1⅛. The highest rate shown by any city in the whole list is 6⅛ per cent. by the city of Pittsburg. Desiring to be liberal and wishing to compare the figures for Memphis with those for St. Louis, I used the same rate as for the latter city, viz: four per cent To bring the death rate in Memphis since the construction of sewers down to what it was before, would, as stated in the note to my former paper, require us to assume an annual rate of increase in the population of eight per cent., or one third more than the maximum rate already mentioned, which, though not in the nature of things an impossibility, is an assumption not to be entertained upon any evidence less than an actual official count.

Nor will it do to take out the strangers and non-residents, who have died in Memphis during the last three years, as Dr. Thornton would have us do, unless we also take them out for former years, in which they no doubt bore just as large a proportion to the whole as they have done since.

So that all the facts in our possession point to the conclusion that in the only city of any importance to which the Waring system has been applied, the death rate has increased rather than diminished, and is 70 per cent. greater than in St. Louis, which has been sewered on the combined system. And for the present the alleged sanitary superiority of the patented system of sewerage rests, as is the case with many other patented systems, upon no better authority than the opinions and assertions of its advocates. And if further experience should show this method of sewerage to be positively unsafe it need not greatly surprise us. For there is one feature of the Memphis work which, it will be remembered, is condemned by the great majority of sanitarians as involving very serious dangers, and that is the untrapped and unflushed house drains. Whilst these remain unchanged the flushing of the main sewers, very many of which probably do not need flushing, is of small consequence; and it may well happen, as has happened in other like cases, that the sewers shall be a means of spreading disease rather than arresting it.

But whilst this feature is a characteristic of the Waring system, and covered by one of the claims of his patent, it is no part of the separate system, which with proper precautions may be made just as safe as any other. And where the sewage needs to be disposed of by any special means, such as pumping or irrigation, or where the cost of the combined system is too great, as in small towns and scattered villages, the separate system is the proper one to be adopted. But, where, as in the particular case under discussion, the question of disposal does not enter, and where the cost is to be borne by a large and prosperous community, the combined system best solves the problem of drainage, and brings the largest return for the money spent.

* Les Organismes de l'atmosphere. Par M. P. Miguel, chef du service micrographique a l'observatoire de Montsouris, Paris. 1883.
Reviewed in *Science*, Vol. III. p., 318, ss.

The figures used by him in his report are these:

			Increase over preceding year.
1880	U. S. Census	33,593.	
1881	Estimate from Directory,	40,000.	19.06 per cent.
1882	" " "	46,014.	15.03 " "
1883	" " "	62,335.	35.47 " "

These figures show rates of increase so enormous and so irregular as to make them, in the absence of an official census, wholly incredible.

Green Mountain Railway, Mount Desert Island.

The Green Mountain railway on Mount Desert Island, Me., is intended for pleasure-travel. It was operated for the first time during the last summer season. It is in a great measure a copy of the railway up Mount Washington, New Hampshire, built some thirteen years ago. These two lines, and the Mount Righi railway in Switzerland, are the only ones employing the central cog-rail as a means of surmounting steep gradients. The trip for tourists from Bar Harbor to the summit of Green Mountain is made, first, by wagons or stages, two miles and a half to Eagle Lake; thence by steamer on the lake two miles; and finally by rail sixty-three hundred feet, in which latter distance the ascent is twelve hundred and seventy feet to the summit, fifteen hundred and thirty-five feet above the sea. While the grade averages about a foot rise in four feet and a half distance, in some places it is as steep as one in three.

Surveys were made, and the work of clearing and grading was begun, in the winter of 1882-83. In April a large force of men was employed, and the road was completed by July 1. The track is not raised on trestle-work, as is the case at Mount Washington: much of it, especially on the heaviest grades, is constructed on the solid ledge. Where the longitudinal timbers, or stringers, rest directly upon the rock, iron bolts one and a quarter inches in diameter, six feet apart, are driven through them into holes drilled in the ledge. Where it is necessary to raise the stringers above the surface in order to make a regular inclination, bed-ties are used every six feet, secured against slipping by two or three one and a quarter inch iron bolts firmly fixed in the rear of each tie. All longitudinal timbers required to bring the line to grade are fastened to the bed-ties with iron bolts of the same size. The timbers and ties in contact with the rock were carefully hewed, and fitted to place. The spruce timber needed for this portion of the work was obtained from a forest-growth on the mountain itself.

The sleepers or ties, six inches square and six feet long, are laid upon the stringers at a distance of two feet from centre to centre, and two seven-eighth inch iron bolts are driven into the stringers, immediately in the rear of each tie, in grooves in the tie, which serve to prevent lateral motion. Upon the ties lie 'T'-rails, joined by fish-plates and bolts, and spiked in the usual way. The rack or cog-rail in the middle of the track is made of two angle-irons which have between them cogs of one and a quarter inch iron accurately rolled to uniform size. This cog-rail is secured to the ties by two lag-screws, five inches and a half long, in every tie, and additional ones at each joint. The rack was manufactured by the Atlantic iron-works, East Boston.

The engine weighs ten tons, and embodies all the improvements suggested by the operation of the White Mountain road. Its entire mechanism is double,—four cylinders, two cog-wheels, and two driving-shafts. Intermediate gearing between the crank-axles and cog-wheels reduces the speed, and increases the tractive force. The cog-wheel axles carry ratchet-wheels with pawls; and either one of these ratchet-wheels, in case of accident to the engine, will hold the train on any grade. In addition, two band-brakes on the smaller shafts may be instantly applied by the engineer. The ascent is made by steam-power; and the engine, when backing down the mountain, is still kept in forward gear, that is, with valves set to go ahead, so that it is constantly pumping air into its boiler; and this air, allowed gradually to escape, exerts an upward tractive force, thus easing the descent.

The floor of the passenger or observation car is adjusted so as to be level on the average grade, and the sides are open to admit of an unobstructed view. The car is always pushed ahead of the engine, and is provided with double hand-brakes, two cog-wheels, ratchet, and pawl, which will easily control the car in descending.—Prof. Chas. E. Greene, in *Science*.

Who Built the Great Pyramid.

At a late meeting held in Cleveland, of the International Institute for Preserving Weights and Measurers, Mr. Latimer read a succinct history of the introduction of the decimal system into France. A bronze medal of the centennial of the adoption of the great seal of the United States was sent the Society by B. A. Mitchell, Philadelphia.

Lieutenant C. A. L. Totten sent a paper on "Early Traditions as to the Object and Builder of the Great Pyramid." In summing up evidence he says: Traditions respecting early written books, and the erection by some celebrated personage of a most important document, by means of which it was hoped and intended to transmit valuable information to a late posterity, are found to exist in countries the most distinct from each other. They are found, too, among the earliest accounts of these nations. They come down to us through persons of almost all religions, Parsees, Hindoos, Greeks, Druids, Mohammedans and Jews.

There is undoubtedly a distinct historic thread of truth on which to harmonize such widespread and such ancient rumor. The leading facts that we may unhesitatingly gather from this united testimony are as follows:

First—That Egypt was the locality.

Second—That round about the diluvian age was the period.

Third—That the patriarch Seth was the ante-diluvian projector and architect.

Fourth—That his indirect pupil and natural successor, Shem, was the post-diluvian and actual builder.

Fifth—That the outcome was an enormous monument built with consummate skill and the fame of which became world-wide.

Sixth—That its object was religious. It was built as a sign and a wonder, containing hidden records of great scientific and religious value, ante-diluvian books, histories, prophecies, etc., all of which were to be preserved for some future era then very remote. The question then before us is: Does such a movement exist to-day in the land of Siriad?

THE interest-bearing debt of the United States has been reduced to $1,256,572,250. The Pacific railroads still owe the government $49,492,759 for interest paid on the bonds issued to them.

Engineering News

AND

AMERICAN CONTRACT JOURNAL.

Tribune Building, - - - New York City.

THE ENGINEERING NEWS PUBLISHING CO. PROPRIETOR.

PUBLISHED EVERY SATURDAY.

CONDUCTED BY

GEO. H. FROST, - - - Assoc. Am. Soc. C. E.
D. McN. STAUFFER, M.Am.Soc.C.E.: M.Inst.C.E.

TERMS OF SUBSCRIPTION:

$4.00.....PER YEAR TO U. S. AND CANADA.
$5.00..... " " " FOREIGN COUNTRIES.

Make all drafts, cheques and money orders payable to Engineering News Publishing Co.

TABLE OF CONTENTS.

	PAGE
The Niagara Cantilever Bridge, *(Illustrated)*.	237
Rural Water Supply	240
Combined Sewers, *vs.* the Waring System—A Rejoinder	242
The Suppression Policy of American Engineers	244
Separate Sewerage *vs.* Waring Patents	244
Personal	245
The Strength and Elasticity of Structural Steel	245
Hydraulic Lifts for Canals	246
Literature	246
Correspondence	247
History and Statistics of Amer. Water Works	247
Water	248
News of Week	248
Markets	250

AMONG the subsidized schemes of the Canadian Government, there appears to be one of some promise in the light of contracts just made by Dr. Norvin Green and Erastus Wiman of New York, the details of which will be seen on another page. Mr. Wiman is looming up as an energetic capitalist and contractor. He has got posession of the Staten Island business and is now building the Staten Island Rapid Transit R. R. He is reported to be a man of large means, he certainly is a man of great energy, and he has been very successful thus far in his enterprises. Dr. Norvin Green of the Western Union Telegraph Co., is a well-known man in contracting circles.

WE publish this week the most complete description of the celebrated Cantilever Bridge that has yet appeared. The text has been compiled from our own and other journals, bringing the scattered literature into one complete article. We have delayed its publication purposely until near the time of the Convention of the American Society at Buffalo, when the visiting members will have an opportunity of visiting the structure itself and examining it with our description in hand.

FOR some months past, visitors to the office of ENGINEERING NEWS have enjoyed the satisfaction of seeing on our walls a series of eight large photographs of the Cantilever Bridge, taken as the work progressed. They are the very artistic productions of G. E. Curtis, photographer, of Niagara Falls, and we are indebted for them to the kind courtesy of Drake Whitney, C. E. of the same place. We do not know the price of them, but they are most appropriate and handsome pictures for an engineer's office or album.

This has been the most exciting week in Wall Street, and other financial centres of America, since the memorable week in September, 1873, when Jay Cooke and the Northern Pacific R. R. Co., collapsed and precipitated the great panic. The continued squeezing of inflated railroad securities, the remarkable developments of the Grant and Ward system of financiering, followed by proofs of the plundering of prominent banking institutions by speculative presidents, brought matters to a crisis on Wednesday, when several prominent firms of brokers, and two banks were obliged to suspend, with the whole country in a fever of excitement and doubt about what was to follow. The general opinion seems to be that it is the final clearing up, and that after the temporary excitement has been allayed, business will go forward on even a more reassured basis than before. The failures thus far are notable as being confined almost wholly to speculative institutions and firms; the country is prosperous, money is abundant, and mercantile failures are comparatively few or serious.

The overbuilding of railways and the discounting by projectors of the future of this country is the principal cause of the present trouble. Railroads where none have been needed have been built; old lines, with their earnings already well cut into by competition have been paralleled in a purely blackmailing spirit; capitalization at a ridiculously inflated price has been made so as to provide double profits for the construction companies composed of officers of the railway companies; and all sorts of disreputable juggling has been resorted to in the process of unloading tons of lithographed fraud upon the country. There is no occasion for sympathy with any of the stock jobbers; there is occasion for genuine sorrow at the misfortunes of the hundreds of innocent investors who are reduced to actual poverty by the misdeeds of the pirates of Wall Street.

The Suppression Policy of American Engineers.

We recently had occasion to investigate, from a historical stand-point, one of the most important branches of civil engineering in America, and were very forcibly struck with the extreme poverty of the literature upon the subject. The only accessible data was made up of scattered newspaper accounts, generally written by unprofessional men, or the reports of engineers who gave the most meagre details, or no details at all; who seemed rather to desire the concealment of their experience than to place it at the disposal of their brethern. In our professional libraries, we found full accounts of how an English, a French or a German engineer had done similar work; but our search after the American practice was discouraging and disappointing.

This should not be; and the profession of civil engineering can not advance in this country, in proportion to the demands upon it, until this evil is corrected. In the case in question, each individual piece of work was an important link in the history of a comparatively new process; and without the consecutive and detailed account of each, no comparison of results nor measure of progress could be made. As a result of this policy of suppression, we found that blunders had been repeated, bad methods copied, and money wasted.

Without the data of previous trials, failures and successes before him, each new engineer had been dependent solely upon his own intelligence, general skill and ingenuity; and as every man is not a genius, many of these men spent their time in groping in paths where others had stumbled before them, instead of improving upon older methods and developing new ideas to the general advance of the profession.

We have heard various reasons advanced for this scarcity of published engineering details. One is, that engineers are too busy—they have no time to write. This excuse is thread-bare, and will not stand the test of an examination; every engineer can *find time*, if he takes a proper interest in his profession, to detail whatever there is new and interesting in his daily practice. If he has no interest in the matter, the profession probably loses little by his reticence.

There is another class of engineers who claim that the knowledge gained by hard work and experience, is private property, their capital in trade, which is not to be spread, even before their professional brethren without a solid return. To this latter class, we say that you are wrong. No one man is the possessor of all knowledge, and the detailed experience of the many is valuable to all; and it is more valuable to the expert than to the beginner, because the first is in a better position to use it. It is only by closely studying the combined experience of a profession, under a variety of conditions, that radical advance can be hoped for, and in this case a history of failure is as useful as that of success.

To the man who fears to tell what he knows, lest others should do likewise, we would say, that no two pieces of work are exactly alike, and a complete description of one undertaking will rarely furnish sufficient data to enable an engineer, who posesses no other knowledge or qualifications, to carry forward successfully another somewhat similar work.

This scattering of information is, after all, little more than a professional duty, and it should be a pleasant duty to each member of the profession to warn his brother of the pitfalls in the way, and to prevent him from repeating the blunders of ignorance and inexperience. If from the vantage point of past experience this brother advances and developes a new idea and a better plan, the class he belongs to is the gainer, and he only paves the way for further good work on the part of his successor.

Foreign engineers evidently do not believe in the suppression policy, if we can judge from the nature and quality of their published reports. The Institution of Civil Engineers gives to its 4,000 members a vast amount of useful detailed information, and not content with English practice, gives excerpts from that of other nations. The engineers of France pursue a still more liberal policy, and their well organized and magnificently equipped national school of engineering is the receptacle for the most minute and detailed accounts of the doings of the working engineers. The student, as well as the expert, has the advantage of this; these plans and estimates and full reports are accessible to all; the best are published, and the novice in the art has the experience of all who went before him to guide or check him in his course. There is complete data to work upon, whatever may be the particular information sought.

The American policy may produce more self-reliant engineers, and be more fruitful in original ideas and plans, but it as often results in disaster to the beginner and a needless waste of public funds. The reverse of the policy would in no wise interfere with the national desire for "something new," nor with the display of Yankee originality. The results would often be only the more brilliant by being built upon a full knowledge of what has been done before.

Separate Sewerage *vs.* Waring Patents.

It is well to bear in mind in discussing the comparative merits of the two principal sewerage systems now in use, that the "separate" system is *not* the so-called "Waring Patent System." The Separate system of sewerage, as opposed to the Combined, is not the invention of Geo. E. Waring; it is not a patented system; it is particularly well adapted to certain localities, to small towns and villages, and to outlying districts having but a small population, and it is recommended by our best engineers, where, in their judgment it is deemed most desirable.

The cities and towns sewered strictly on the Waring patent system in this country, can be counted on the fingers of one hand; there are full a score of other places using the separate system as recommended by such engineers as Bowdoin, Clarke, Hering, Croes, and some others.

The Waring patents consist of a combina-

tion of certain features, the principal ones being:

1. Absolute exclusion of all rain-fall.

2. Ventilation of street sewers through pipes which are not trapped against the sewer.

3. Autumatic flush tanks at the head of all street sewers:

4. Soil drainage by tiles laid in sewer trench.

The separate system makes use of such amounts of roof water as the engineer deems advisable to admit to the sewer for flushing purposes; if *any* such water is allowed to enter the Waring sewer, the patent is void: and so likewise of the other provisions of the patents.

While Col. Waring should be awarded all the credit due him as an energetic engineer and advocate of a particular system of sewerage, yet it is well for engineers and others to know that his patent system is only the adaptation of certain appliances to a system of sewering that is free to all who choose to adopt it as the best suited for their needs.

PERSONAL.

CYRUS G. FORCE, Jr., M. Am. Soc. C. E., has been appointed City Civil Engineer of Cleveland, O., vice B. F. MORSE, resigned.

THE following city officials of Dallas, Tex., were elected by the City Council on the 6th. A. M. WHELESS, superintendent water-works; W. M. JOHNSON, city engineer.

D. H. RHODES has been appointed engineer of the Atchison, Topeka and Santa Fe Railroad to fill the vacancy caused by the death of GEO. B. LAKE, and C. M RATHBURN is appointed superintendent of the Western Division of the road.

RUDOLPH HERING, Sanitary Engineer, Assistant Engineer in charge of New Water Supply Surveys for Philadelphia, was in New York on Monday last. Mr. and Mrs. Hering will attend the Buffalo Convention of the American Society.

W. H. SEARLES, M. Am. Soc. C. E., and author of the popular works "Field Engineering" and "Spiral Curves," was in New York on Tuesday. MR. SEARLES has just completed the construction of the Beach Creek, Clearfield and South Western R. R., of which he was Chief Engineer, with office at Elyria, O. He will spend a few days at Stamford, Conn., and with Mrs. Searles will attend the Buffalo Convention of the American Society.

DEXTER BRACKETT, of the City Engineer's office, Boston, Mass., was in New York on Friday of last week on his way to Washington. MR. BRACKETT is the First Assistant Engineer in the Boston Water Department, in which office he has spent his entire professional life. Previous to the creation of the Meter Department, MR. BRACKETT was in charge also of meter tests, and he now has the superintendence of the new Deacon Waste Detectors, being introduced by the city. MR. BRACKETT is just recovering from a severe illness, and will spend two weeks in Washington before returning to New York, where he will also spend a few days.

WE are selling from 25 to 40 copies per week of our cheap edition of Latham's Sanitary Engineering. There are not enough copies in all to supply even 25 per cent. of our subscribers; Van Nostrand is a large buyer of them to supply his customers, and there are numerous calls from other dealers; we propose to clear out the entire stock as rapidly as possible, after which there will absolutely be no chance to buy under $12, the price of the English copy. N. B. We will, from this date until the entire edition is sold, send to any subscriber who will send us a *new* subscriber to ENGINEERING NEWS, with $4, one copy of Sanitary Engineering, post paid to any address. The book will always be worth $2 to sell again.

The Strength and Elasticity of Structural Steel.

A paper was read at the meeting of the American Society of Civil Engineers last week by James Christie, M. Am. Soc. C. E., on "The Strength and Elasticity of Structural Steel, and its Efficiency in the form of Beams and Struts." The author said that the various grades of steel possess such a range of physical properties, that it is impossible to consider the metal as one might treat of iron. It is customary to denominate the grades of steel by the percentage of carbon they contain. The higher the carbon, the higher the tenacity of the steel and the lower its ductility. Steel whose carbon is below fifteen hundredths per cent. is conventionally known as *mild* or *soft* steel. The steels subjected to the tests described in this paper were of two distinct grades—mild and hard; both being products of the Bessemer convertor, the hard steel having thirty-six hundredths per cent. of carbon, and the mild steel twelve hundredths per cent. The tensile tests were made on strips about 24 inches long to which were clamped plates exactly 12 inches apart. The compression tests were made on specimens 12 inches long inserted in a tube, and the space between the specimens and the tube filled with fine sand. The tests on transverse resistance were made on bars of 3 or 4 inches diameter, and solid flanged beams from 3 to 12 inches deep, all being supported at the ends and loaded in the middle.

Extended tables were then presented of these various tests, and it was stated that the results showed that the elasticity of steel and iron is practically uniform; the steel may stretch less than the iron in tension but the steel shortens most under compression. Transversely, if there is any practical difference, the advantage in stiffness probably belongs to steel, but the elasticity of both metals is so close and uncertain that further experiments may modify the average results here found. The specimens show that the elastic limits for tensile and compressive stress for the different grades of steel are practically equal per unit of section, and the transverse resistance is approximately proportionate to the longitudinal resistance, and that the strength of the material indicated on tensile stress will serve as a comparative measure of the absolute strength of iron, or of either grade of steel; but as the transverse elasticity is practically alike, beams of iron or of either grade of steel of the same length and section will deflect alike under equal loads below the elastic limit of iron.

Tables were presented of experiments on flat ended struts of both mild and hard steel. It was stated that the experiments on direct tension and compression prove that the elastic limits of steel of any particular grade are practically equal per unit of section for either direction of stress. A similar equality is known to obtain with iron. Therefore for the short struts, in which failure results from the effects of direct compression, the tensile resistance of the material will serve as a comparative measure of struts resistance. As struts increase in length, the lateral stiffness becomes a factor of increasing importance.

The transverse elasticity of steel and iron does not vary much. The tendency will be for struts of steel and iron to approach equality of resistance as the lengths are increased. Mild steel will fall to equality with iron when the ratio of length to least radius of gyration is about 200 to 1. Hard steel would fall to practical equality at the point beyond the bounds of practice.

This paper, and the paper previously presented by Mr. Christie, giving experiments on the strength of wrought-iron struts were then discussed.

Mr. A. P. Boller expressed the opinion that the variations in the compressive resistance of iron shown by these very careful experiments, were so great that it was impracticable from them, or from any other experiments so far as had yet been made, to prepare a formula which would ever give satisfactory results, and that dependence must be placed upon experimental charts which will express extreme values for all sections progressively determined.

Mr. Onward Bates considered that the experiments developed the great importance of placing the center line of pressure coincident with the center of the struts. If this could be done perfectly a round ended strut would be as good as a flat ended one. In actual practice in the construction of bridges, the methods of securing the ends of such struts are so various, that it is impracticable to make from such experiments a table of safe loads. The only safe practice is that of low unit strains corresponding to the lowest results of recorded tests.

Prof. E. A. Fuertes considered that the areas of cross-sections should be obtained by direct measurement instead of deriving them from the weight and length of the bars, particularly when the specific gavity of the material is not determined. The reason why an accurately centered straight bar behaved as a flat ended strut, when hinged, is due to the friction developed by pressure on the bearing of the hinge, and the early failure of flat ended struts was probably due to the want of parallelism between the planes at the extremities or the one or both of these planes being warped surfaces. Since a bar very long in proportion to its radius of gyration fails with a comparatively light load without permanent injury, it would seem proper that such load should be given a name other than ultimate load, the latter being restricted to its bearing on the the elastic limit.

Mr. Theodore Cooper considered the experiments of Mr. Christie most valuable, particularly in carrying out a complete series with different end connections upon the same class of materials. The paper shows that slight changes in the direction of the lines of applied forces produce great changes in the results. By interchanging different sizes of ball and socket joints it shows the influence of the size upon compressive resistance of the struts. It gives a more complete knowledge of the action of struts of high ratios of length to transverse dimensions than before existed. The method of using the least radius of gyration instead of the last dimension gives a fair comparison between the various forms. Attention was called to the relation of the ball and sockets to the transverse dimensions of the struts, and diagrams were presented by Mr. Cooper showing the influence of the size of pins relative to the width of the struts. From the great effects of non-centering the line of applied force upon columns and of initial, though minute, bends in the materials, and the increased influence of possible side blows, it is very important not only to keep the working strains within proper limits, but also to specify a limit to the number of diameters to be used in all columns. In recent specifications this limit has been about at 45 diameters corresponding approximately to about 120 radii of gyration for the usual forms of bridge columns. With this proviso a practical formula may be reduced to very simple forms.

Mr. E. B. Dorsey presented some comparative tests of iron and steel.

The subject was further discussed by Messrs. Bouscaren, Charles E. Emery, Pegram, Percival Roberts, jr., Towne and Christie.

THE first Londoner, according to the *Builder*, who introduced conduit water into his premises was a tradesman of Fleet street. This is how a record of 1478 sets forth the occurrence: "A wex chandler in Fleet-street had by crafte perced a pipe of the condit withynne the ground, and so conveied the water into his selar; wherefore he was judged to ride through the citie with a condit uppon his hedde," the city crier meanwhile preceding the criminal and proclaiming his offense.

Hydraulic Lifts for Canals.

Written for ENGINEERING NEWS.

BY W. R. HUTTON, M. AM. SOC. C. E.

The operations of the French Government in completing and perfecting a system of navigable water lines, have led to the revival and development of several methods of great interest. Among these the use of elevators or hydraulic lifts to overcome great differences of level, has attracted much attention, and will receive an important practical application.

At Anderton, on the River Weaver, in England, there has been in operation since 1876, an "hydraulic lift lock," by which boats are transferred from the Trent and Mersey Canal to the river, a height of 50 feet. It is composed of two plate iron caissons, filled with water in which the barges float; one ascends as the other descends. Each rests upon the ram of an hydraulic press which is sunk within an iron tube below the river bed. The presses are connected, so that water can pass from one to the other when the valve is open or, being disconnected, pressure may be applied to either ram from an accumulator. The two caissons may thus be balanced, each upon one arm of an U shaped water-column. To produce motion in this hydrostatic balance, a sufficient weight of water is added to one caisson to overcome friction and inertia. This is taken from the upper reach of the canal, while the caisson is at the top of the lift, and discharged by automatic syphons when, after completing its descent, it commences again to ascend.

In operation, when one caisson, containing water 5′ deep, with or without boats, is at the top of the lift, the other is immersed in the river at the bottom. The one at the top being the heavier, descends as soon as the connecting valve between the presses is opened, and lifts the lower one, until becoming in its turn immersed, it loses a part of its weight. The ascending caisson is now nearly at the top of the lift. The connection between the presses is closed and the accumulator is used to raise the upper one to its place. Meantime the water is run out of the press of the descending caisson, which is carried down by its own weight to its position in the river.

The caisson when at the top of the lift is in contact with the end of the head-bay of the canal, which is a plate iron trunk on iron columns, closed at the end, like the caissons, by a sliding gate.

Each caisson is 75′ long, 15′ wide, and with its load of water (4′ 6″ to 5′ deep), and the ram of its hydraulic press weighs 250 tons. The ram is 3′ in diameter and works with a pressure of about 520 pounds to the square inch.

The caissons are kept in position by guides attached to towers, formed of braced columns, at the angles of the caissons.

In 1882 at Anderton one of the presses burst, and the caisson fell from the top of the lift to the water, fortunately without doing serious damage.

The general design was by Edwin Clark, details by Sidingham Duer.

The Anderton elevator has been described because it has become, in its general form and arrangement, the model for the larger ones about to be built in France.

In 1881 it was decided to construct at Fontinettes, near Saint Omer, a lift of 13.13 metres (43′) for barges carrying 300 tons of load. Designs were invited from Mr. Duer and from Mr. Clark, and that of the latter was adopted.

In Mr. Duer's plan, as in the Anderton lift, the caisson in its lower position is immersed in water, but it is not borne by a single press. To carry a boat of 300 tons, the caisson with its load and movable connections would weigh 800 tons, and would require, if a single ram were used, one of 2 metres (6.56′) in diameter. Moreover the overhang of one-half the caisson on each side of the ram, would equal 60 feet. Mr. Duer therefore employs two *pairs* of presses at one-fourth the length from each end of the caisson, connecting each one with the *symmetrical* press of the corresponding pair under the other caisson. Each press is made strong enough to support half the entire weight of its caisson, therefore in the event that one of them should be ruptured, the caisson would not be left without support.

The plan of Mr. Clark is very different. Each caisson is carried by a single ram 2 metres (6.56′) in diameter under a pressure of 27 to 28 atmospheres (362 to 412 pounds to the square inch). It descends, not into the water, but into a dry basin, the caisson being connected with the water in the lower reach by gates as it is above. As one ram descends and the other rises, the weight of water in so large a press becomes important. To meet this difficulty—viz.: the excess of weight in the press of that caisson which is above mid-height—each caisson is connected by flexible pipes with a vertical column of the diameter and height of the body of the press, in which the water will stand at the same height that it does in the caisson, forming, as it were, an equalizing reservoir. Each caisson therefore, as it ascends or descends discharges into this reservoir, or receives from it precisely the quantity of water that has passed into the press of the ascending caisson, or out of the press of the descending branch, and the weight of each system—caisson and water column—remains unchanged.

Similar lifts have been designed by Mr. Clark for Belgian Canals, but *it is said* that since the accident at Anderton they have been abandoned for inclined planes.

Messrs. Clark, Stanfield & Clark have also designed what has been called a "single-track" elevator. There are still two caissons, but they are placed one at the end of the other, in the line of the canal. One rises to half the height of the lift, meets there the other caisson which has descended from the top, and transfers to it the boat. The movements are then reversed, the second caisson carries the boat to the top of the lift, while the first returns to the bottom. The details are similar to those of their design for Fontinettes. As before the presses are connected, and their movements are in contrary directions. A modification of this plan shows an intermediate passing basin at mid-height, between the ends of the caissons which it connects, for the purpose of passing boats in opposite directions at one operation of the lift. Thus as one boat ascends the lower half of the lift, the other descends from the top, they go from their respective caissons into the basin, pass each other, each enters the other caisson, and in it completes its course.

Mr. Seyrig, of the well known firm of Eiffel & Co., has submitted a project based upon a different principle. A single caisson is carried by four towers formed of braced columns, which rest upon the same number of cylindrical floats, submerged in deep wells filled with water. The buoyancy of the floats is made a little less than the weight of the entire structure, so that it will descend by its weight to the lower level, and the application of a very small power will cause it to ascend. For a lift of 20.50 m (67.27′) the floats as designed are about 14 m long (45.94′) by 5.70 m (18.70′) in diameter, and the wells which are lined with masonry, are 37. m (121.42′) deep. The floats are kept in position by rollers running against rails built into the sides of the wells, and the caisson, as usual, is guided at the corners. A small press is used to give motion to the system

Hydraulic lifts for ships of much greater weight have been designed by Captain Eads to lift from the water and place upon the carriages, the ships to be transported on his Tehuantepec Ship Railway, and more recently they have been suggested for a proposed ship railway along the Suez canal. These however, like the lifts of the Victoria, the Malta, and the Bombay Docks, carry the ship on a cradle, not afloat in a vessel of water.

LITERATURE.

Transaction and Proceedings of the American Society of Civil Engineers for January, 1884.

This Number is just issued, being delayed so as to contain the Annual Reports for 1883. The papers contained in the present number are—"Metrological Investigations," by O. E. Michaelis, and "Recent Dredging Operations at Oakland Harbor, California," by L. J. Le Conte; both papers are illustrated.

The paper of Mr. O. E. Michaelis describes some very delicate investigations into the coincidence of the axes of the conoidal and cylindrical portions of a standard steel bullet; a modified spherometer, or Tripod Caliper, designed by Mr. Michaelis, in his search after a more reliable means of determining contact than by the gravity touch, and lastly the investigation of instrumental or screw error.

By the Tripod Caliper, which is illustrated, the thousandth part of one turn of the measuring screw was readily and accurately determined; but as no screw can be made with perfectly uniform pitch throughout, Mr. Michaelis describes the method by which he endeavored to determined the error of a single turn of the measuring screw.

The paper of Mr. Le Conte describes the dredging operations now going on in Oakland Harbor, Cal., under the direction of Col. G. H. Mendell, Corps of Engineers, U. S. A. The machine used is a Pump-dredge, which excavates, transports and deposits on shore the dredged material, which is utilized in reclaiming adjoining salt-marshes. The excavation is done by a horizontal wheel with ordinary plows rigged on its lower face, over this is a hood that only allows water to enter from beneath, and into the top of this hood is placed the lower end of a 20 in. suction pipe, which leads up to a large centrifugal pump with a runner 6 ft. in diameter. Two 16 × 20 inch engines run the pump, and two 12 × 12 inch engines drive the cutting apparatus, swinging gear, winches, etc. Two 100 H. P. boilers supply the steam, the working pressure of the steam being from 90 to 95 pounds.

The material excavated is described as a sticky blue clay, quite uniform in character. This is carried from the dredge to the point of deposit by a line of wrought-iron pipe 20 in. in diameter, supported partly on pontoons, and partly on the marsh. The pipe line has been carried a distance of 2,000 ft. from the dredge. The percentage of material transported is subject to great variations, passing from nothing, or clean water, to 40 per cent. by volume. Experience has proved that it is not advisable, however, to carry more than 15 per cent. of sclids. The percentage of water should be sufficiently great to insure a widespread and uniform distribution of the material.

The total quantity put ashore by one dredge in 8 months was 250,000 cu. yds., an average of 30,000 cu. yds. per month. The best month's work was 60,000 cu. yds. in 230 engine hours, average distance of transportation 1,100 ft. The greatest distance transported was 45,000 cu. yds. delivered in 190 engine hours through 1,600 to 2,000 ft. of 20 inch pipe. The average regular expenses for a day of ten hours are $102.30; there are some extra expenses, including the construction and maintenance of levees to confine the material, and the shore crew of 9 or 10 men, at the mouth of the pipe.

In the past, it has cost, on the Pacific coast, not less than 24 cents, measured in the scows, to fill in low lands with dredged material. This cost is mainly due to the double-handling required. With the new dredge, the average of 30,000 cu. yds. per month, cost 10 cents per cu. yd; and in one month of 23 days work, 60,000 cu. yds. was placed on shore 1,600 to 2,000 ft. from dredge for 5 cents per cu. yd.

The "Proceedings" issued with the present number is mainly taken up with the report of the last annual meeting and those of the

different officials and committees of the society. The total membership, on Jan. 1, 1884, was 795, showing an actual gain of 39 members within the year. The library now contains 10,433 books, 128 manuscripts, 2,343 maps, plans, etc., and 430 models and specimens.

Annual Report, for 1883, of the City Engineer of Omaha Nebraska. Andrew Rosewater, City Engineer.

At the end of 1882 Omaha had just commenced the paving of its streets; to March 1, 1884 a total of 79,660 sq. yds. have been laid, aggregating in cost $268,948.40.

Of the city sewerage system, $10\frac{26}{100}$ miles have been built; 13,723 ft. of this amount was constructed within the last year, at a cost of $98,493.57. The engineer states that while there has been considerable trouble experienced in some of the lateral sewers, constructed on the Waring or separate system, these defects were mainly due to the absence of necessary manholes, and to the fact that there are ten hydraulic elevators on one line and eleven on the other, near the point affected, all these elevators being concentrated within a few blocks. Mr. Rosewater says that 1,050,000 gallons of sewage is being discharged daily, three-fourths of this coming through four lines of six-inch pipe. As compared to the Memphis system, which discharges 70 gallons per load, the Omaha sewers discharge nearly 350 gallons; showing that in the latter place there is much service performed in excess of simple sewerage discharge.

In grading streets, in the year 1883, 396,794 cu. yds. of earth have been moved, costing $81,101.84.

The work outlined for 1884, includes:

Paving streets and alleys and st. railways	$429,121.65
Sewerage	146,500.00
Grading, curbing, etc.	110,000.00
Miscellaneous	14,378.35
Total work for 1884	$700,000.000

The total Engineering expenses for the year 1883 was $9,678.09, which was less than two per cent. of the cost of the work in charge.

The Magazine of Art for May and June.

Beautifully illustrated; excellent reading; rich in information in art subjects. Published monthly, by Cassell & Co., 739 Broadway, New York. Price $3.50 per year.

DECATUR, GA., is a quaint old town which 40 years ago refused to allow a railroad station to be buit there, and thus made way for Atlanta, six miles further up. The town Council passed two ordinances on the 6th, one forbidding children to play marbles on the streets, and the other allowfng hogs to run at large.

CORRESPONDENCE.

Frogs and Switches.

Special Correspondence Engineering News.

326 WALNUT ST, PHILADELPHIA, May, 14, 1884.

EDITOR ENGINEERING NEWS:—In your issue of 10th inst. you reprint from "School of Mines Quarterly" a paper by Mr. W. B. Parsons, Jr., in which he speaks of the old-time practice of considering the switch rails as tangents, and measuring the "lead" or frog distance from *toe* of switch to point of frog, and says "Trautwine too, in his 'Hand Book for Engineers' (up to the last edition, when he makes correction), was deceived by the same fallacy, and thinks that lead is dependent on length of switch instead of frog angle and throw."

While it was at my instance that my father made the change above referred to, it is but proper to say that I did not then, and do not now, regard it as a "correction," but simply as an improvement, bringing the article into harmony with modern practice, and greatly simplifying the formula.

The old view was based upon the old practice of confining the heel of the switch rail at a single point in a chair, so that the rail *did* remain straight after moving, and the length of lead (being measured from the *toe*) *was* dependent on the length of the switch. And even when (as now) the switch rail is spiked for some distance from the heel, so as to spring to a curve when thrown, the old view, although cumbersome, would give practically correct results, and we cannot, therefore, properly call it a "fallacy".

JOHN C. TRAUTWINE, JR.

Phosphorescent Light.

SILVERTON, COL., May 9, 1884.

EDITOR ENGINEERING NEWS

In your issue of April 19th, Straw & Lyte make inquiry concerning a phosphorescent light to be kept in a bottle. I did not think it worth while to answer it, being so far away, as I felt sure that some one living near would answer it before my letter could reach you, but as I have not yet seen any answer to it, here it is.

Take an oblong vial of clear, white glass, put in a piece of phosphorus about as large as a pea; heat some olive oil to boiling heat, pour upon the phosphorus till the vial is about one-third full, and cork tightly. To use it, withdraw the cork and then re-cork; the empty space will become luminous and equal to an ordinary lamp. If the light becomes dim before you are through with it, open it again and let in more air. In very cold weather, it may be necessary to heat the apparatus a little to increase the fluidity of the oil. With only occasional use it will last six months or more.

Yours, &c.,

PLUMMET LAMP.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

B. J. JAMES R. CROES, M. AM. SOC. C. E. : M. INST. C. E.

(*Continued from page 234*)

DCXXXIII. ALMA, MICH.

Alma, Gratiot Co., Michigan, in lat. 43° 25′ N., long. 84° 30′ W., is on Pine River.

Settled in 1854, it was incorporated a village in 1873. Water-works were built in 1882 by the village after plans of M. Walker the supply being taken from the river and pumped by a water power pump of 8 in. cylinder and 12 in. stroke, made by M. Walker, directly into the mains. The ordinary pressure is 20 lbs. and the fire pressure 75 lbs.

Distribution is by one mile of Wyckoff wooden pipe of 8 to 4 in. diameter, with 11 fire hydrants, 3 gates, and 12 taps.

The cost of the works has been $6,000.

The bonded debt is $5,000 at 6 per cent.

The population in 1880 was 925.

No further information is given.

DCXXXIV. PORT HOPE, ONT.

Port Hope, Durham Co., Ontario in lat. 43° 50′ N., long. 78° 20′ W. is on Lake Ontario at the mouth of Smith's Creek.

The business portion of the town is built in the valley on both sides of the creek, the hills on either side being chiefly occupied by residences.

Settled in 1793, it was incorporated a town in 1850.

Water-works were built by the town in 1874 after plans of John Helm, the supply being taken from the creek. The water is pumped by a rotary pump driven by water power, made by Wm. Hamilton, directly into the mains, furnishing a fire pressure of 300 lbs.

Distribution is by 1½ miles of cast-iron pipe 6 in. diameter with 30 hydrants and 2 gates.

The population in 1880 was 5,585. The works have cost $20.000. The expenses of maintenance in 1883 were $500. No further information is given. Jonn Gamble is superintendent.

DCXXXV. WESTMINSTER, MD.

Westminster Carroll Co., Maryland in lat. 39° 33″ N., long. 76° 55″ W., is on rolling ground at the head water of the Patapsco River.

Settled in 1775, it was incorporated a town in 1858.

Water-works were built in 1883 by a private company after plans of Col. W. W. Taylor, the supply being taken from 3 springs one mile southeast of the town.

The water is conducted by earthenware pipes from the spring to a pool holding 500,000 gallons from which it passes through wire screens to a pump well, and is pumped by a Worthington Steam Pump, having a daily capacity of 500,000 gallons to a circular reservoir 12 feet deep and 150 ft. in diameter, constructed in earth embankment riprapped and puddled, and being 145 feet above the pump and 180 feet above the lowest point in town. Distribution is by 5 miles of cast and wrought-iron pipe of 8 to 4 in. diameter, with 40 fire hydrants, 10 gates, and 175 taps. Service pipes are of galvanized iron. The town pays for fire service at the rate of 5 cents on every $100 of assessible property within the limits, the amount now being about $1,000 yearly. The population in 1880 was 2,507.

The capital stock of the company is $20,000, and its bonded debt $20,000 at 6 per cent. The cost of the works has been $25,000. W. W. Taylor is General Manager, and A. H. Huber Secretary.

DCXXXVI. DANVILLE, ILL.

Danville, Illinois, in lat. 40° 8′ N., long. 87° 40′ W. the County Seat of Vermillion County is on the Vermillion River in a rich and densely settled agricultural region, and owes its importance chiefly to the mining of bituminuous coal. It was settled about 1810 and is now an incorporated city.

Water-works were built in 1883 by a private company, after plans of K. P. Corbyn and Frank Shefold, and under the direction of J. M. Carson, taking the supply from the North Fork of the Vermillion River. A 20 inch pipe carried through a masonry revetment wall into the stream delivers the water at the bottom of a settling well 40½ feet in diameter and 27 feet deep, holding at the average stage of the river 180,000 gallons, and thence it is carried through a 20-inch pipe to a pump well 18 ft. in diameter. The supply pipes are so arranged that a direct connection from the river to the pump well can be made when it is necessary to clean out the settling well.

The water is then pumped by two duplex high-pressure Blake Steam pumps, having a combined daily capacity of 4,000,000 gallons, to a sand pipe 200 ft. high and 40 in. in diameter, of ½ inch iron, double riveted for the rest of the height, founded on masonry 12 feet square and 12 feet thick, and having a brick casing for the first 100 feet. The ordinary pressure is 40 to 60 lbs. and the fire pressure 110 lbs.

It is now proposed to supplement the supply from the river by building an impounding reservoir, into which water from springs will be gathered.

Distribution is by 13½ miles of cast-iron pipe of 14 to 4 in. diameter with 101 fire hydrants, 67 gates, 17 meters and 218 taps. Service pipes are of galvanized iron.

The city pays $7,562.50, yearly for the use of hydrants.

The population in 1880 was 7,733, it is now said to be 14.000.

The capital stock of the company is $200,000, the bonded debt is $150,000 at 6 per cent. No further financial statement is given. Samuel A. Miller is President, and Wm. Reinecke Secretary.

DCXXXVII. CHICOPEE FALLS, MASS.

Chicopee Falls, Massachusetts, in lat. 42° 10′ N., long. 72° 35′ W., is on the Chicopee River, a tributary of the Connecticut River. The village is part of the town of Chicopee which was settled in 1640, and formed the Northern part of Springfield, until separated from that city in 1848.

Water-works were built in 1882 and 1883, jointly, by the Chicopee Manufacturing Company, and the village, water being taken from the river and pumped by the pumps of the company to a reservoir from which a fire-pressure is obtained of 40 to 65 lbs.

Distribution is by ½ mile of cast-iron pipe of 8 to 3 in. diameter, with 40 fire hydrants, 12 gates, and 200 taps.

Service pipes are of iron. The population is stated as about 4,000

The pipe is controlled by the village fire commissioners, the reservoir being owned and the supply furnished by the company for ½ the water rents, and $365 yearly for hydrants.

The cost of the works has been $20,000. The bonded debt is is $14,250. The receipts

for 1883 were $803. Wm. O'Neil is President of the commission and Henry J. Boyd Treasurer.

DCXXXVIII. FORT COLLINS, COL.

Fort Collins, Colorado, in lat. 40° 30' N., lon. 105° W., is on the Cache la Poudre River Its site is level and 5 mile east of the foot hills of a spur of the Rocky Mountains.

Settled in 1865 it was incorporated a city in 1873. Water-works were built in 1883 by the city, after plans of H. P. Handy, taking the supply from the river at a point about 5 miles west of the city. The water is filtered through a wooden crib filled with cobblestone and gravel, and passes in an open canal 400 ft. to a settling reservoir formed by a dam across a ravine, constructed of earth with a center of 3 in. spruce plank, having a capacity of 3,000,000 gallons, and flows thence one mile to a reservoir, holding 2,000,000 gallons, and is thence pumped by 4 Holly Steam Pumps, having a capacity of 1,500,000 gallons daily, through a force main of lap-welded wrought-iron 12 in. in diameter, directly into the mains. The ordinary pressure is 70 lbs., and the fire pressure 155 lbs.

Distribution is by 8 miles of lap-welded wrought-iron pipe of 8 to 4 in. diameter with 40 fire hydrants, 5 gates and 140 taps. Service pipes are of lead and galvanized iron. The works have cost $105,000.

The bonded debt is $85,000 at 7 per cent., and $20,000 at 8 per cent. The population in 1880 was 1,356. H. W. Owens is superintendent.

WATER.

A COMPANY is being organized at Pekin, Ill., to bring the water from Bailey's lake into that city.

AN artesian well at Diana, Sanborn county, Dakota, at a depth of 110 feet, yields about 1,200 barrels of water an hour.

THE Tampico Water Works have suspended work for the present hoping to resume again in about two months, or when the political or financial situation is improved. Mr. Sydney Smith was Civil Engineer, and he arrived in this city on the 14th by the steamer British Empire.

The Central R. R. Co., are putting in bridges and laying track. Mr. Farrar had just arrived from Vera Cruz to investigate the practicability of opening the bar at Tuspan. General business is very dull in Mexico, and there is a universal lack of financial confidence there.

MR. GEO. H. NORMAN, of Boston, has made the city of Bath, Me., a proposition to furnish the city with a water supply. He will lay the main, put in hydrants, and pay all the expenses, provided the citizens of Bath will agree to take the water for use in their houses, the city to pay a special sum for the use of hydrants.

CLEBURNE, Tex., May 8.—The final official test of the new water works system was made this afternoon before the City Council, under a pump pressure of 230 pounds. Four streams were thrown at one time to a height of 100 feet. The contract stipulated for a pressure of 200 pounds. As far as can be learned the test was thoroughly satisfactory. The committee will report at the next meeting of the council, and the matter will then be acted upon.

The water works contractors have made the city a a proposition to take the system and run it, furnishing fire protection at a certain rate per hydrant, and paying the interest and sinking fund of the bonds.

BIG SPRINGS, Tex., May 5. A full-flowing stream of water was struck at the artesian well, last Friday, at a depth of 800 feet. The whole town is jubilant over this living fountain, and there is no longer any apprehension about the future of this place. The doubt hitherto expressed about procuring water has been a serious impediment to the building up of this town.

The committee chosen at the Holbrook, Mass., annual town meeting to investigate the best sources for a water supply seem to be working up a decided sentiment in favor of supplying this town with water from Weymouth Pond. It is almost universally admitted that water must soon be introduced for fire and domestic purposes, and expressions favorable to the immediate movement are heard on every hand.

THE new contract with the Waco, Texas, Water Company now before that City Council is greatly agitating the people of this city just now. A majority of the aldermen, backed by the city press, appear determined to adopt the new contract, and the people, at least a large majority of them, are opposed to the new contract, and will, by all reasonable means, resist the City Council in its attempt to saddle the onerous measure on the people. The next meeting of the council, which takes place next Thursday night, promises to be one of the most exciting in the history of the city.

DEAN BROS. Steam Pump Works, Indianapolis, Ind. have furnished the Rust Owens Lumber Co., at Drummond, Wis., a system of water-works including pumping machinery, pipe and hydrants, having a capacity of one million gallons in twenty four hours.

THE practicability of artesian wells as a source of water supply for villages has been very satisfactorily demonstated in South Evanston, Ind. By boring to a depth of 1,000 feet a powerful flow of pure, fresh water has been obtained, which is now being distributed throughout the streets in under-ground iron pipes to the residents of the village, without the aid of pumping works or other machinery, the natural force of the well itself being sufficient for all practical purposes. The water flows at the rate of 350 gallons a minute. The expense of boring the well was reported to be only, $3,800.

J. D. COOK, the well known Hydraulic Engineer, of Toledo, O., has taken the contract for building the entire Lexington, Ky., Water-Works. Direct pumping system. Includes construction of an impounding reservoir of 80,000,000 gallons capacity, 14 miles of cast-iron Water Pipe to be supplied by the Ohio Pipe Co., of Columbus, O., 200 Holly Fire Hydrants, 2 Gaskill compound condensing engines. Work commences at once and to be completed in November.

MR. M. DINNEEN, the efficient superintendent of city water-works of Staunton, Va., having been offered his old post of engineer at the Western Lunatic Asylum, tendered to the City Council his resignation, which the Council refused to accept. Mr. Dinneen afterwards withdrew his resignation. His report showed that there are over twelve miles of water-pipes in the city, and that during the year 225,513,568 gallons of water had been pumped and 842,720 pounds of coal consumed. The water tax for the year amounts to $11,543.

THE regular monthly meeting of the Board of Water-works' trustees was held yesterday. Mr. W. H. Lutton, who was re-elected a member at the recent municipal election, took his seat, and the board proceeded to organize. Mr. Walter Blythe, the oldest member, was chosen for president. Mr. H. C. Hawkins, who has been secretary of the board since 1865, having expressed himself against a re-election, Mr. William Madison, the assistant secretary of the old board, was unanimously chosen secretary, and Mr. Hawkins elected his assistant. Engineer John Whitelaw was reappointed for the eighteenth time.

The April claims, amounting to $45,481.52, were approved, after which the board considered the bids for the removal of the two Cornish pumping engines, stand pipe, and six Cornish boilers, from the West Side pumping station to the Fairmount street reservoir, and put the same in running order. The bids were approximately as follows: W. H. Thompson and E. H. Martin, $36,920; Frank Rieley and William L. Rieley, $31,552; Globe Iron Works, $24,060; Chafer & Becker, $18,537; Variety Iron Work, $23,930 The board deferred the letting of the contract until Friday evening. The board then adjourned.—Cleveland *Evening News*, 7th.

PHILADELPHIA ADDITIONAL WATER SUPPLY.—The office work of last season's surveys is nearly completed, and parties will soon be in the field for this season's surveys. The study of the different conduit lines from Delaware Water Gap, the Lehigh above the coal region, and the Perkiomen, to Philadelphia has been completed. These lines are so evenly balanced as regards respective merits, that no decided preference can yet be given to any one. The best water has been found in the Lehigh, but the cost of getting it is the greatest. This seasons surveys will probably decide the matter of which line to take. The most important problem is to get pure water and lots of it; the secondary one is the relative cost of getting it.

The work this year embraces the surveys of the Perkiomen, Tohickon, and Neshaminy water-sheds; all the surveys cover about 400 square miles of territory, and together constitute the largest survey of the kind ever made in this country. Rain gaugings over all the territory are taken at 15 stations; analyses of the water of different creeks and rivers are being made by Prof. Leeds, of Hoboken, N. J., the streams are all being gauged by means of 8 weirs, and by current meters.

Col. William Ludlow is Chief Engineer; the entire surveys of these water-sheds and the study of these lines from which to select the best one, are in charge of Rudolph Hering, the now widely known Sanitary Engineer; 12 men have been engaged in the office work during the winter and spring; this force will be increased for field work: *every vacancy* is filled, with a long list of new applicants already on file.

NEWS OF THE WEEK.

Streets, Drainage, Sewerage, Etc.

WASHINGTON, May 12.—The bill providing for the completion of the sewerage system in this District, was passed in the House to-day almost without opposition.

THE council of the village of Stryker, Ohio, have made provision for sewering Defiance Street. Plans and specifications have been completed. Ten in. 12 in. and 15 in. sewer pipe is to be used. Estimated cost, $2,637.73.

Survey made, and plans prepared by John C. Grim, C. E.

Bridges, Tunnels, Etc.

THERE were turned out 2,549,362 pounds of manufactured iron by the Philadelphia Bridge Works for the month of April. At this rate the output would average over 15,000 tons per annum.

THE Pittsburg Bridge Company has orders enough on hand to keep its shops busy for four months. The company is now shipping the iron for a street bridge in St. Louis, which is to be 1500 feet long.

THE King Iron Bridge Company, of Cleveland, O., was awarded the contract of bridging the Blue River at Shelbyville, Ind., for $10,000.

THE Kansas City Bridge and Iron Company has taken a contract to build a Howe-truss bridge of 150 feet span over Blue River, near Kansas City, Mo., for the Belt Road.

THE Phœnix Iron Company have commenced shipping tubes for the cable railroads of Philadelphia. They are also shipping the iron for a large bridge to be erected in Oregon.

THOMAS H. and Z. H. Withers will erect a foundry and machine shops at Marietta, Ga., for the purpose of making engines for gold mining and mill machinery, saw and planing mills.

THE Clifton Iron Company, of Talladega, Ala., has just contracted for the largest charcoal furnace in the South, to be built at the new town of Jenifer, on the East Tennessee and A. A. Road, between Annison and Talladega.

MR. ISAAC REEVES, mill superintendent at the Phœnix Iron Company's new mill, shape iron department, in Phœnixville, has accepted a position with the Philadelphia Iron and Steel Company as manager of their works near Kensington.

ARKANSAS CITY, Ark., May 10.—The information received here is that a party of Eastern capitalists are now in Arkansas City with a view of constructing a railroad from that place to Shreveport, La.

TERRE HAUTE, Ind., May 7, 1884.—The county commissioners of this (Vigo) county have just sold to N. W. Harris & Co., investment bankers of Chicago, $160,000 of 5 per cent. bonds, proceeds to be used in building of the new court house.

SAN ANTONIO, Tex., May 5.—Alderman Lockwood introduced a resolution in the City Council this evening, authorizing the issue of 6 per cent. thirty year bonds to the amount of $150,000, for the purpose of establishing and maintaining a thorough system of surface drainage for the city. The resolution was referred to the finance committee.

SOMERSET, May 13.—A large part of the roof of the Eastern end of the South Pennsylvania tunnel, under the Allegheny Mountains, at Dexter's Gap, caved in on Saturday afternoon, instantly killing two men and badly injuring three others. The tunnel was being pushed with great vigor when it struck a quicksand, and before any precaution could be taken the roof came down with a crash, Superintendent White had just gone into the tunnel, and was so badly crushed that there is little hope of his recovery.

Gas and Electricity.

HARRIBURG, May 12.—The business of issuing charters at the State department for natural gas-light and heat companies in Armstrong County keeps up briskly. To-day charters were issued for companies in the townships of Gilpin, Boggs, Kittanning, Warren, Bethel, East Franklin and Laughlin, each with a capital of $1200. There is talk of extending the natural gas system to the East, the gas to be supplied through pipes, and the projectors of the scheme say they can pump it as far East as Philadelphia, and make a handsome profit by selling it much cheaper than manufactured gas.

In view of this, shrewd capitalists are securing charters for natural gas companies in the large Eastern cities. Philadelphia and Reading having been preempted, and a Harrisburg company applied for.

Should the system be extended East, these franchises will be valuable only in one event, and that is, a favorable decision from the Supreme Court in the Pittsburg case. It was held there that, as in the case with manufactured gas companies, a charter could only be issued to one natural gas corporation in a city. The matter was taken to the Supreme Court, and if the lower court is sustained the incor-

porators of the Eastern concerns will realize well, because the owners of the gas cannot come in unless they do so under the charters already held.

Contracting Miscellany.

THE contract for the construction of sewers in Calhoun, Vine, McMillan, Jefferson and other streets, Cincinnati, O., was awarded to B. D. Barton, at $22,823.14.

THE Supervising Architect of the Treasury has awarded to Z. Downing, of Washington, D. C., the contract for the construction of the Marine hospital buildiugs at Cairo, Ill.

FITZ SIMONS and Connell have been awarded the contract for the pile and timber protections for the Rush St. Bridge, Chicago. Price $10,329.

THE May Number of *Carpentry and Building*, published at 63 Reade St., New York City, gives an interesting article on the condition and prospects of the Building Trades in the United States at the present time. Parties interested ought to send for that number.

THE contract for building the masonry on the extension of the Lehigh Valley Railway into Buffalo, N. Y., has been given to James Smith, of Easton, Pa. This extension is about two miles long.

MR. WM. MUNZER, manufacturer of an improved Corliss engine, found his quarters at the corner of 1st avenue and 30th streets, N. Y., too small, and is now moving to Nos. 204 to 210 E. 43rd street. His new works will be very large and complete. A rapid increase of business is the cause of the removal.

LEAVENWORTH, KAN., May 9.—The highest temperature to-day was 84; lowest temperature, 56.5; mean barometer, 30,018; mean temperature, 70; mean humidity, 44 per cent.; prevailing wind, southwest; character of weather, clear; stage of water in the river, 13 feet above low water mark and rising. Stationary or lower barometer, with higher temperature. Mean temperature same date 1882, 67; 1883, 70.

THE Benson & McNee dredging machine, with which it is proposed to dredge North River at Salem, Mass., is a suction machine, draining the ooze from the river bed up through a mammoth pipe and discharging through pipe in the same way. The machine has powerful engines, two huge smoke-stacks, and looks like a mammoth steamer. It will cost about $50,000 to build and about $85,000 entire for the whole work.

TUSCUMBIA, Ala., May 8.—The Seney syndicate of New York, together with Atlanta capitalists, has purchased 3,000 acres of land in Colbert County and laid out a city, the first lots of which were sold to-day at auction. Although there is not a building on the entire premises, one hundred and eighteen lots were sold for $130,000, an unprecedented price for Southern land. Five thousand people were present at the bidding for lots. The stock of the corporation has gone up 500 per cent. The principal investors are from New York, Philadelphia, Atlanta, Chicago, Mobile, New Orleans and St. Louis.

The new Sheffield is on the Tennessee River, at the head of navigation, and thousands will be spent to make it the iron manufacturing centre of Alabama, to cheapen the cost of iron with a view to attracting manufactures. A new railroad to the coal and iron beds of eighteen miles was completed to-day, and contracts were made for the erection of three furnaces, gas and water-works, and hotel to cost $30,000. Ten thousand people are here to-day, among whom were Governor O'Neill and Robert P. Porter.

THIS relative stringency in the East, as compared with the West, does not exist in all trades. *Carpentry and Building*, which has just completed its careful annual review of the building trades, finds that operations are most active in the New England and Middle States, less so in the West and comparatively unchanged in the South. With the exception of places like St. Paul and Minneapolis, little building on a large scale is reported in progress in the Northwestern States, and wages are only from 10 to 15 per cent in advance of those farther East, although higher in the extreme West. In the seaboard cities, on the other hand, building is said to be in full progress, with contracts likely to keep labor employed through the summer. This circumstance is likely to have an important effect upon the real estate market, on the demand for building materials, particularly iron, and on labor.—Philadelphia *Press*.

A BILL introduced by Representative Slocum, on the 12th, for the improvement of navigation at the entrance of New York Harbor, directs the Secretary of War to invite proposals for twenty days for the deepening of Gedney's Channel through Sandy Hook Bar to the extent of 5 feet beyond its present depth, and for a width of not less than 500 feet. The bill provides that no bid of more than $1,000,000 shall be accepted, and that one-half of the sum agreed upon shall be paid on the completion of the work, and the other half when the increased depth shall have been maintained six months. It prohibits the use of any material in the execution of the work which shall obstruct navigation. The sum of $15,000 is appropriated to enable the Secretary of War to cause surveys to be made during the progress of the work. In conclusion, the bill directs the Secretary of War, if he deems it advisable, to require the contractor to maintain the increased depth for not exceeding ten years for annual compensation of 10 per cent. of the contract price for the improvement.

Railroads and Canals.

LAST January there were 518 miles of railroad under construction in Austria on which 20,139 men were employed. More than three-fourths of the new mileage was State railroad.

SURVEYS for the Cincinnati, Van Wert and Michigan R. R. have been completed to Bryan, O., and work commenced at that point this week.

THE following is a good illustration of the practical working of a strike: The 600 Italian laborers on the new Schuylkill Valley Railroad, who struck for an increase of wages from $1.25 to $1.35 a day have returned to work to-day at $1.15 a day. They heard that the contractors had received an offer of 300 foreign laborers delivered here free of railroad charges from New York for $1.25 a day, and this caused a stampede to resume work.

A DISPATCH from Des Moines, Iowa, states that the Eastern and Western Air Line Railway have filed articles of incorporation with the Secretary of State of Iowa. The new company proposes to build an air line from Mercer, Penn., to Council Bluffs, Iowa, a distance of a little more than 900 miles. The projectors say that this line will save nearly 300 miles over any other route that can be selected. It is asserted that the projected road will not vary more than six miles either way from an air line. It is to cross the Mississippi River at Keithsburg, Ill. Provision is also made in the articles for a line crossing the Mississippi River in a south-westerly direction to the Missouri State line in Van Buren County. The capital stock of the Eastern and Western Air Line Railway Company is 13,000,000. The names signed to the articles are Thomas W. Osborn and Waldo R. F. Philips, of New York, and J. W. Trey, of Des Moines.

DAYTON, Ohio, May 8.—Cornelius Vanderbilt passed through here to-day, en route for Cincinnati, in a special coach, making the fastest time on record. The train consisted of two coaches and came from Lima, here, a distance of 74 miles, in 66 minutes. It went from here to Hamilton, according to telegraphic instructions from there, a distance of 35 miles, in 36 minutes. The train started from Detroit, making the entire trip to Cincinnati, 263 miles, over the Canada Southern, Dayton and Michigan and Cincinnati, Hamilton and Dayton Lines in 5 hours and 30 minutes, an average of 50.7 miles an hour. A number of stops were made and engines were changed three times, at Toledo, Lima and Dayton. The run between here and Cincinnati was made in one hour and nine minutes. The train was run through all cities at a rate of speed complying with the ordinances of the city. It is estimated that in some places the train traveled a mile in from 48 to 52 seconds.

DR. NORVIN GREEN, President of the Western Union Telegraph Company, and Mr. Erastus Wiman, of New York, have concluded an important contract with the Dominion Government for the completion of a section of 360 miles of the Montreal and European Short Line Railroad. Various subsidies were granted in the last and previous sessions by Parliament to this undertaking, which, when grouped together, amount to $20,000 per mile for the number of miles to be constructed, including an immediate transfer to this company of 80 miles of completed road, known as the eastern extension, fully equipped and recently acquired by the Government. In addition to this, there is a local subsidy, land grant, and free right of way. A Government survey is now being made to determine the shortest route, which will also be subsidized, for a Western connection for this company across New Brunswick and the State of Maine, to connect with roads in Quebec already constructed, which could be consolidated into the Short Line. The company's system, when completed, will make the shortest route from New York, Chicago and Montreal to St. John, Halifax, and Louisburg, the latter being in the extreme eastern part of the Dominion, from which the ocean passage to Queenstown, taking the time of the steam-ship Oregon, as a standard, can be reduced to three and a half days. The manager for the company in Canada, Col. C. L. Snow, left on the 9th for Nova Scotia with Sir Charles Tupper, Minister of Railways, to arrange for commencing work on the new undertaking.

A VERDICT for $10,000 damages was rendered last week by a jury in the Supreme Court, in favor of Charles S. Hine and against the New York Elevated Railroad Company. Mr. Hine is the owner of the premises at No. 13 Bowery, in front of which the Chatham-square station of the defendant company is situated. He sued for $15,000 damages, alleging that light and air were excluded from his premises by the railroad stucture; that access to his property was obstructed by it, and that the gas, smoke, dust, and cinders from the locomotives made it impossible at times to keep the windows of the building open.

The case was tried before Judge Van Vorst, who kept the record clear of the great mass of matters that have hitherto been presented to juries in similar suits. He ruled that the plaintiff was entitled to recover damages measured by the diminution of the value of his premises resulting not merely from the presence of the railroad structure but also from the cutting off by it of air, light, and ease of access, and that he could not recover the aggregate difference between the yearly rentals of the premises before the railroad was built and the yearly rentals since that event, but that the rentals could only be taken by the jury as the basis of a computation to determine the past and present values of the property. The Judge also ruled that damages could not be recovered for the emission of smoke, dirt, and gas by the locomotives, unless it was proved that the smoke, dirt, and gas stopped the passage of light and air into the building; and that no damages at all could be recovered for the noise of trains, because noise was necessarily incidental to the lawful operation of the railroad.

In the opinion of the jury the premises are now worth $10,000 less than they were in 1878, when the elevated railroad was built. Mr. William H. Arnoux and Gen. Stewart L. Woodford appeared for Mr. Hine, and Messrs. Henry H. Anderson and Charles H. Bauerdorf for the New-York Elevated Railroad Company.

THE Michigan Central R. R.—President Ledyard's report shows that there are 1,468 miles of road operated. About 10,000 tons of new steel rails have been laid between Kensington and Detroit, and 6,000 tons between Windsor and Welland. The entire main line, and all but 287 miles of branches are now laid with steel rails. Seven bridges have been rebuilt. Fifty-one engines and 934 cars have been added to the rolling stock. The yard improvements in Detroit include 1,000 feet of new dock, three and a half acres of earth-work filled, and the construction of several miles of new track.

The Canada Southern improvements include the building of the Cantilever bridge at Niagara, the replacement of the Kettle River bridge, the building of the Niagara River branch, 14 miles long, purchase of 12 cars and 36 engines, and the completion of an iron transfer boat carrying 21 freight cars. The locomotives of the combined system have run 14,154,792 miles, at a cost of 17 cents a mile. A 31 mile run consumes one ton of coal. There are 396 locomotives, all coal-burners except one, of which the Canada Southern owns 125. There are 269 passenger cars and 11,544 freight cars. There were 5,197,278 tons of freight moved during the year at an average rate of 830-1,000 of one cent per ton per mile. Two million nine hundred and nine thousand two hundred and twenty-three passengers were hauled at an average rate of 2 217-1,000 cents per passenger per mile.

The gross revenues from traffic have been as follows: For the year 1883, the combined system, $14,009,766.69; for the year 1882, Michigan Central system, $8,913,081.24; Canada Southern system, $3,416,958.91; total, $12,330,040.15. An increase of 13.62 per cent., or $1,679,726.54. This result is favorable, especially in view of the deficiency of the crops in Michigan and Ontario with the consequent loss from local traffic, and it may safely be regarded as an earnest of the expectation following the combination of the two systems. The gross expenses were as follows: For the year 1883, combined system, $9,741,638.45; for the year 1882, Michigan Central system, $6,671,726.56; Canada Southern system, $2,597,179.25; total, $9,268,905.81, an increase of 5.10 per cent. or $472,732.64.

THE longest trestle-work in water in the world is on the New Orleans and North-eastern Division of the Cincinnati, New Orleans and Texas Pacific Road. It runs through Lake Pontchartrain, and is twenty-two miles long.

THE smallest locomotive in America has been built by a Pensacola firm. The drive-wheels are only twelve inches in diameter, and the whole machine is only nine feet six inches long.

STATISTICS show that seventeen out of twenty railroad officials, who die under the age of fifty years, are employed on bankrupt or practically bankrupt roads, and thier deaths are generally occasioned by undue mental exertion and anxiety.

THE Wabash has been assessed the modest sum of $30,000 by the Allen County (Indiana) Ditch Commissioners for the draining of the big swamp along the line between Roanoke and Fort Wayne. The company will object to paying it.

THE St. Paul, Brainerd & Northwestern Railway Company has been organized. The principal office is Brainerd and they propose building a road from St. Paul, via Princeton and Brainerd to some point on the Red River of the North.

THE Crookston, Minn., and Southwestern R. R. Co. has been incorporated. Capital $2,000,000. The officers are Thomas B. Walker, of Minneapolis, President; John Cromb, Vice President; Davis Brower, Treasurer, and W. M. Ross of Crookston, Secretary.

THE Oregon Railway and Navigation and the Oregon Short Line are rapidly pushing their respective roads to a junction at Baker City. About 110 miles of road remain to be completed, the bulk of which is graded and ready for the iron.

THE Chief Engineer of the Kansas City, Fort Scott and Gulf Railroad, with a corps of assistants, has begun the survey for the proposed extension of that line eastward from Lacygne. It is surmised that the eastern terminus of the road will be St. Louis.

THE American Railway Construction Company, of Chicago, elected the following officers recently: Edward F. Cullerton, President; Albert Michelson, Vice-president; Chas. H. Nash, Consulting Engineer and general superintendent; E. R. Wells, Secretary and Treasurer.

THE Fort Smith and Sabine Pass. R. R. Co. has been organized at Texarkana, Tex. The following were elected directors: J. H. Draugon, C. E. Bramble and L. A. Byrne, of Texarkana; J. H. Fleming, of Little Rock; C. B. Neal, of Greenwood, Ark.; J. B. Hussy, of Indiana, and John Carroll and Thomas Sonigan, of Fort Smith. It is certain the road will be built.

THE Fitchburg Railroad has a party making a survey of a route from Fitchburg to Manchester. The line is through Townsend, Hollis, Amherst and Bedford. It is a route that has been talked of a good deal in the past few years, but whether or not there is a serious purpose to build the road is a matter of which the public know little or nothing. There is a live charter for such a road.

CAST iron wheels have been making a big mileage record on the Louisville and Nashville Road. Of 652 wheels noted they have made a total mileage of 48,072,376 miles; average per wheel, 73,730 miles; amount refunded by the makers for reclamation, 2,805,598 miles; virtually increasing mileage to 78,033 miles. Average cost, $12.50; average scrap value, $8, cost per 1,000 miles, 5.7 cents.

A BRANCH of the Georgia Pacific under the name of the Birmingham and Tennessee River railroad, is being built northeastwardly from Birmingham Ala., to the Tennessee River at a point in Colbert County. At this place, the head of river navigation, a new town has been laid out which is to be named Sheffield. It is expected that this embryo city will have such a rapid growth that in a few years it will rival in extent the great manufacturing center in England, after which it is called.

IT is claimed that the projected N. Y. Arcade Railway when finished will have a capacity of a million passengers a day; that its express trains will run from City Hall to Harlem River in twenty minutes; that the progress of its construction will cause no interruption to travel or traffic and no disturbance of the sewers or the gas or water mains, which will be transferred to a subway under the tracks; that the road instead of injuring Broadway property will enormously increase its value by making the thoroughfare once more the chief artery of travel. If half of these claims are substantiated the Arcade road will be a great institution indeed.

THE Selma & Tennessee River Co. has filed articles of incorporation to build a railroad from Selma, Ala,, northward to the Tennessee line, crossing the Tennessee River near Florence. This is one of the several projects for lines through North Alabama.

A MEETING of stockholders of the Kansas City and Southern Railroad Company was held at Kansas City Wednesday the 7th and elected officers for the ensuing year as follows: President, William Bailey; Treasurer, William C. Smith; Secretary, Amos T. Anney; Directors, William Bailey, E. L. Martin, E. G. Meecham, J. W. Miller and Wm. T. Johnson of Missouri, Amos Tenney, S. J. Clarke and S. G. Wheeler of New York. The road is projected between Kansas City and Memphis, to cross the St. Louis and San Francisco Road near Marshfield or Lebanon, Mo. Ten miles are now in operation. It was resolved to commence active construction shortly, beginning work at three points, and it is expected the line will be completed to the intersection with the St. Louis and San Francisco within the year.

CANADA R. R. PROJECTS.—St. Catharine has voted a bonus of $80,000 to the contemplated St. Catharines & Niagara Central R.

J. R. Booth, lumberman, of Ottawa, is building a five mile railroad for himself between Lake Nipissing and Lake Nosbonsing. The railway will cost about $100,000, and is to carry timber towards its outlet to market.

Parliament has incorporated the following companies: Lake Nipissing & James Bay R. Co.; Gananoque, Perth & James Bay R. Co.; Guelph Junction R. Co.; Vaudreuil & Prescott R. R. Co.; Saskatoon & Northern R. R. Co.; Alberta R. Co.; St. Clair Frontier Tunnel Co.: Quebec R. R. Bridge Co.

The House of Commons has just granted subsidies to the following railways:

To the Quebec Government, for the North Shore, from Quebec to Montreal, $6,000 per mile, or $954,000.

To the Quebec Government, for the North Shore, from Montreal to Ottawa, $12,000 per mile, or $1,140,000.

To construct a line from Montreal to Halifax and St. John by the shortest route, $170,000 per year for 15 years.

For the construction of a line from Oxford Station, on the Intercolonial R. R., to Sydney and Louisburg, $30,000 per year for 15 years.

To the Quebec Central R.R. Co. for a line from Beauce Junction to the international boundary line, $211,200.

For the extension of the Canadian Pacific R. from its terminus at St. Martin's Junction near Montreal, to Quebec, $960,000.

To the Irondale, Bancroft & Ottawa R. Co. for a line from the Victoria branch of the Midland Road to Bancroft village, Hastings county, $160,000.

To the Pacific Junction R., from Aylmer to Pembroke, $272,000.

To the Gatineau Valley R., from Razabazua to Lake Desert, $160,000.

To the Napanee & Tamworth R. R., from Tamworth to Bogart, Ontario, and Bridgewater, $70,400.

To the Montreal & Western R. Co., for a line from Lake Simon to Desert, $160,000.

To the Miramichi Valley R., from Fredericton to the Miramichi river, $128,000, in lieu of the subsidy proposed last year.

To the Erie & Huron R., from Wallaceburg to Sarnia, $96,000.

To the Ontario & Pacific R., from Cornwall to Perth, $262,400.

To the Kingston & Pembroke R., from Mississippi to Renfrew, $48,000.

To the Great Northern R., from that portion of the line between St. Jerome and New Glasgow, Terre Bonne County, $32,000.

For a bridge and a line of railways from the junction of the Jacques Union R. with the Canadian Pacific R. to St. Martin's Junction, connecting the Jacques Union R. with the North Shore R proper, $200,000.

For a railway from St. Louis to Richebucto, $22,400.

For a railway from Hopewell to Alma, N. B., $51,200.

For a railway from St. Andrews to Lachute, county of Argenteuil, Quebec, $22,400.

For a railway from Grand Piles on the St. Maurice river, to Lake des Isles, $217,500.

For a line from Digby to Annapolis, N. S., $64,000.

For a branch of the Central R., from the head of Grand Lake to the Intercolonial R., between Sussex and St. John, N. B., $128,000.

For the extension of the line from Caraquet to Shippegan, N. B., $76,800.

For a branch of the Intercolonial R. from Metapediac east toward Pasebia, Quebec, $300,000.

For a branch of the Intercolonial R., from Deroy Station to Indian Town, $140,000.

The Souris & Rocky Mountain R. Co., has changed its name to the Northwest Central Railroad Co.

IRON, METAL AND COAL MARKETS.

PHILADELPHIA, May 16, 1884.

The eastern iron markets are already feeling the influences of the probable lock-out in the West. The latest heavy order placed this week was for 1,400 tons of manufactured iron. There are some few inquiries in hand, a few for large, but most of them for small lots, the effect of which has been to make prices of refined iron a little firmer. It is probable that prices will remain firmer until it is definitely ascertained whether there will be a lock-out in the West or not. Our advices here to-day are, that it will likely take place. If work continues, the capacity cannot be more than half engaged. Common Iron is selling at 1.70; Refined Iron, 1.90. A sale of Muck Bars was made yesterday at 32.00. Nails sell at from $2.40@$2.60. Orders are not abundant because builders prefer to wait and buy as they have need. The blowing out of a blast furnace is heard of now and then. Stocks of Anthracite Iron are declining month by month. This ought to have the effect of improving prices, but it does not. Production is not increasing because of the firmness of coal. Very few orders have been given out this week for Construction Iron. Steel Rails are still on the downward march. $33.00 is asked for Winter Delivery, but will not be paid.

PITTSBURG May 15, 1884.

To-day's indications are that there will be a lock-out. No efforts are being made to avoid this result. The Amalgamated Association is prepared for, and, in fact, rather welcomes, a suspension. Refined Iron can be had at 1.70. The demand is not sufficient to keep all our mills going. Painter's Mill, which has been running on single turn, has started up double. During the past few days 5,741,000 bushels of coal have been shipped down the river. There is nothing new in the iron or coal trades. Nails are selling at $2.30. A good deal of building activity is reported. It is probable that natural gas fuel will be introduced for light and heat for domestic purposes. The Glass trade is quiet and prices are firm.

CHICAGO, May 15, 1884.

The northwestern coal and iron market have met with a little improvement during the last few days in consequence of the low condition of stocks in some directions. The improvement in the iron trade is also partly due to the apprehension that there will be a general lockout in the West, and as everybody has been buying only what they needed from week to week, they find themselves in bad shape in case of any such event taking place. Hence a good many have been making inquiries, and a good many orders have been booked at the leading establishments. In fact, however, stocks are large enough in manufacturers' hands to meet all probable requirements, and buyers need be under no apprehension on that score. The Northwest can stand a long suspension. The railroads are not heavy purchasers. Nails are in amply supply, and Sheet, Galvanized, Russia and other Irons are in hand in sufficient quantity to be up to all requirements for some time to come. Steel Rails are occasionally asked for, but no orders are being taken. 2,000 miles of railway building will be done this year, but the contracts for this are mostly already placed. Carriage and agricultural implement manufactories are fairly supplied and there will be no great rush for material. The smaller establishments are working along quietly and do not feel any pinch. A good deal of engineering work is in hand, into which considerable iron and steel are going. A fair amount of business is being done in Gas, Water and Steam Pipe, and there is considerable inquiry for electrical appliances of one sort or another.

COAL.

PHILADELPHIA, May 16, 1884

The fact that the six days' suspension of last week has not brought out buyers nor improved prices, is accepted as an indication that the Coal Combination will not be able to keep prices firm. It is rumored to-day that a revision of circular rates is not far off. The fact is, that there is a great deal of shading going on. Some of the handlers of inferior coal are driving the better coal out by low prices. The East is not doing as well as was counted upon, neither have western orders come up to the expectation. Stocks, in both cases, are below what they would be if prices were firm. One cause of the trouble is that vessels are scarce, and freights high, at least 15c. above what New England parties are willing to pay. The western markets, at present, have rather short supplies and negotiations are in progress which will lead to shipments next week. Another restriction will probably be announced in June. Fall and winter contracts are being sought with considerable avidity. The Bituminous trade is improving as to volume of business, but prices are very low.

BRIDGE OVER THE MONONGAHELA R

MR. G. LINDE

Fig. 1.

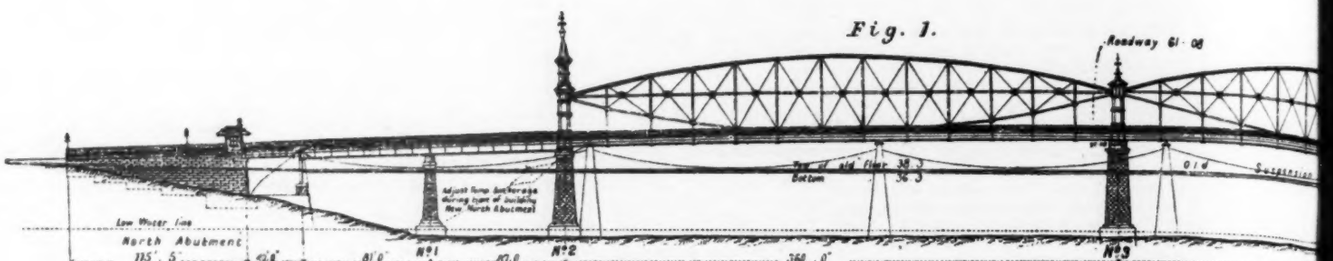


Fig. 2.

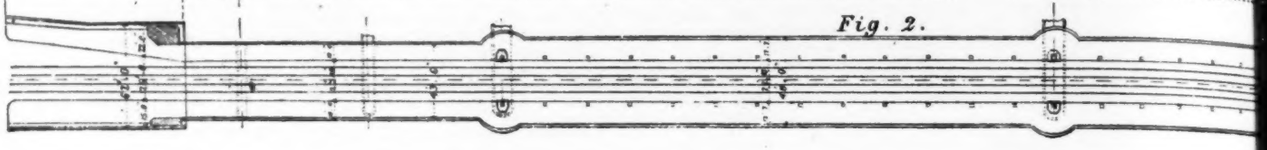


Fig. 5.

Fig. 3.

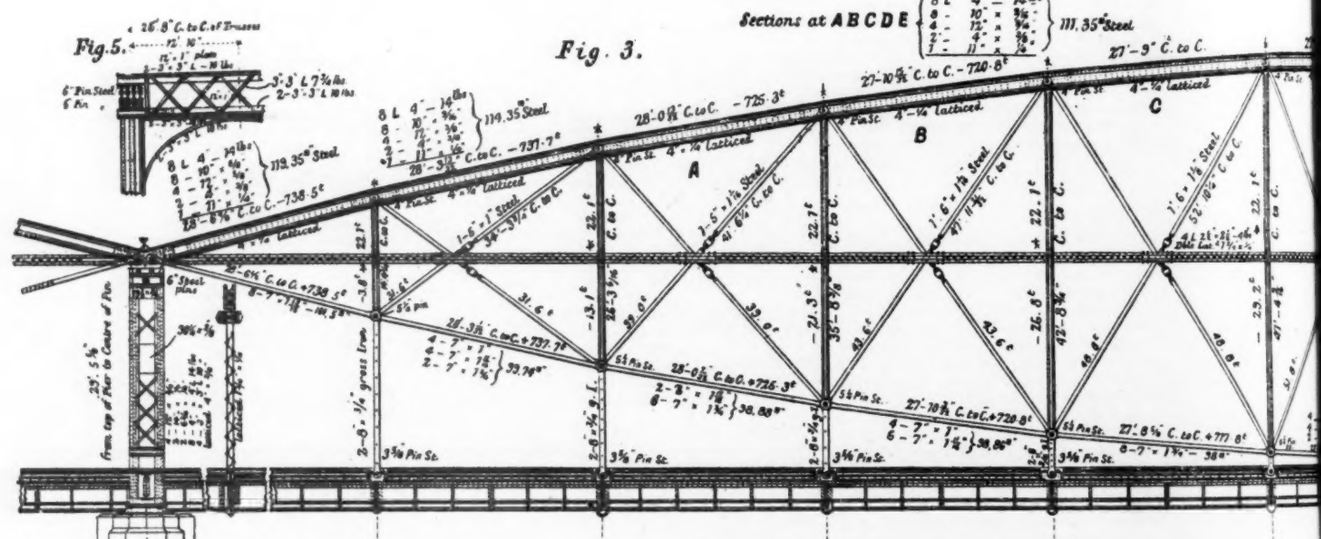
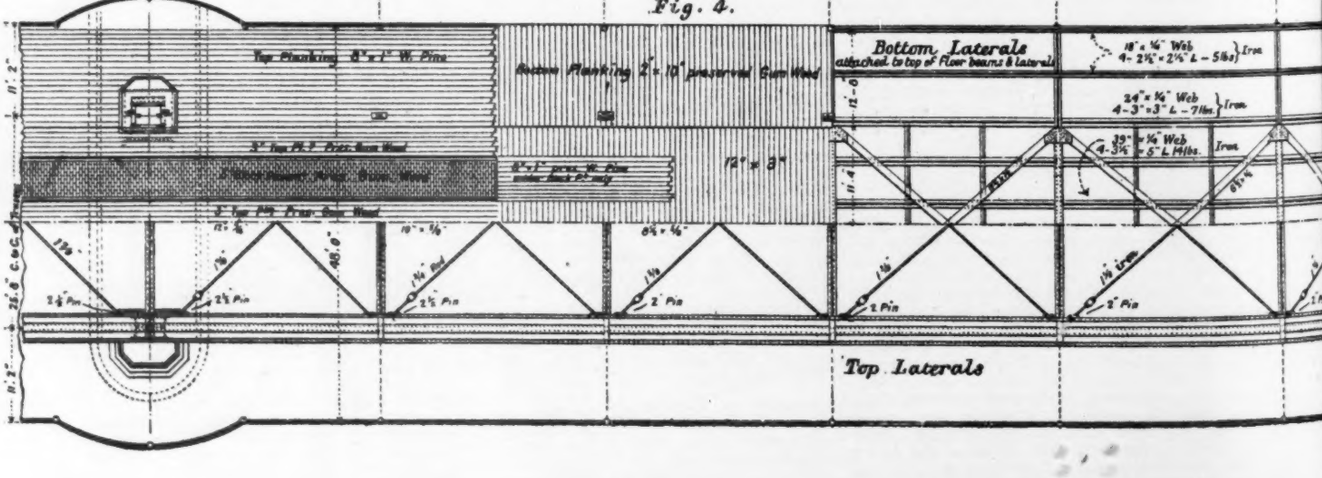
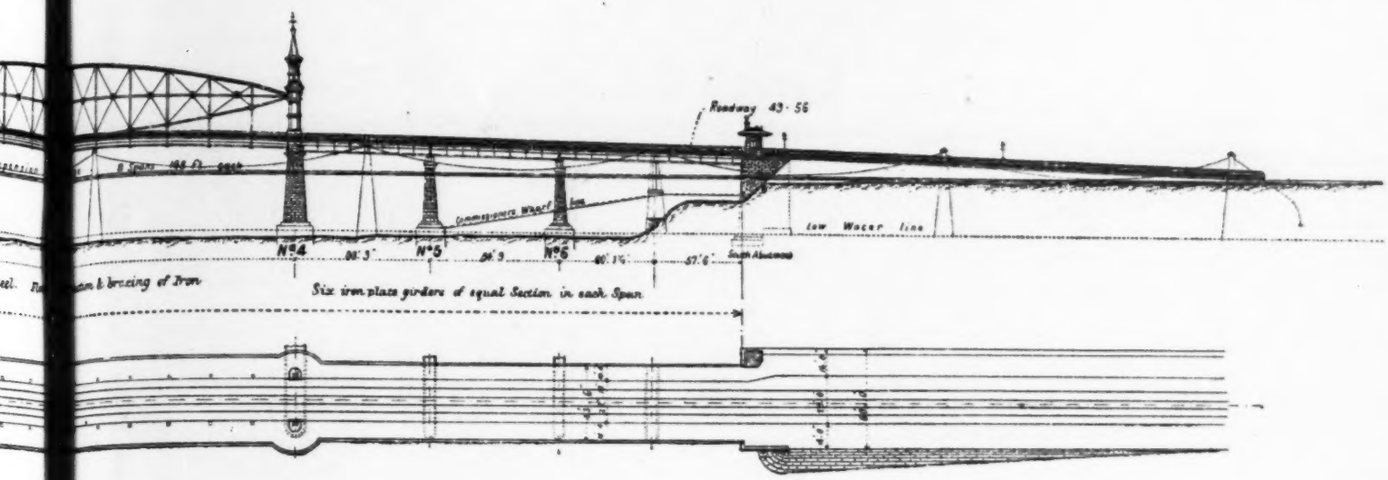


Fig. 4.


Top Planking 3" x 1" W. Pine
Bottom Planking 2" x 10" preserved Gum Wood
Bottom Laterals
attached to top of Floor beams & Laterals
Top Laterals
12" x 3"

ER, PITTSBURGH, PENNSYLVANIA, U.S.A.

INDE[illegible], ENGINEER.



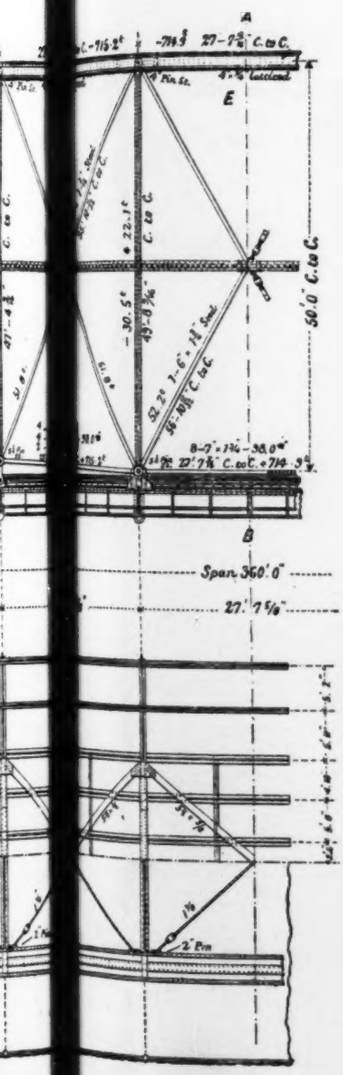
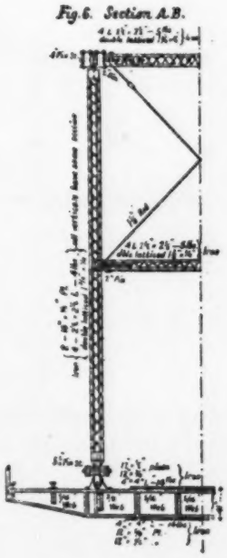


Fig. 6. Section A.B.



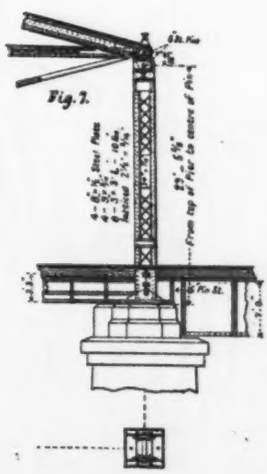
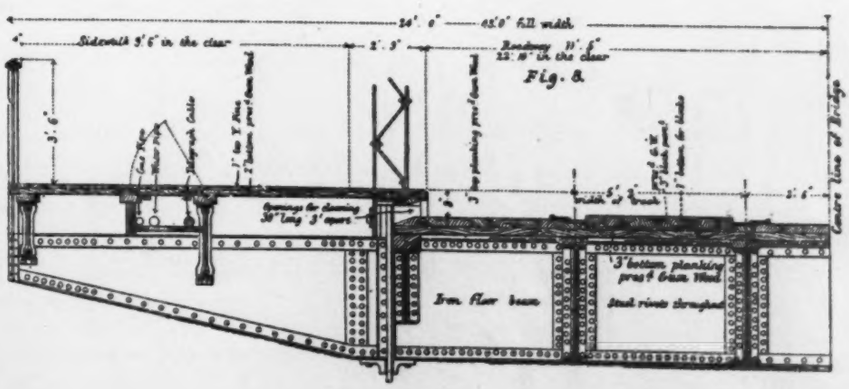



Fig. 7.